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THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

I. EARLY STEPS IN IRON-MAKING.

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TO all familiar with the iron and steel industries of this country it will be manifest that the story of their technological development can not possibly be told exhaustively in a magazine article, whose length is scarcely sufficient for an adequate description of a single one of the larger mechanisms employed in working iron or steel at the present time. Therefore, all that will be attempted in these papers is such a description of the beginning, growth, and present state of the technology of these vulcanian industries as will enable non-professional readers to obtain an intelligent idea of the more important improvements in machinery and methods that have contributed to a progress which, by successive steps, albeit oftentimes short, slow, and uncertain, has brought these industries safely through the manifold perils of three hundred years to their present wonderful expansion.*

All authorities agree in the opinion that iron was unknown to the aboriginal inhabitants of America. Tools, weapons, ornaments, and culinary vessels made of copper were occasionally found in their possession, but nothing of iron.

* In the preparation of these papers I am indebted to James M. Swank, Vice-President and General Manager of the American Iron and Steel Association, for the opportunity to consult the library of the Association; and for extracts from his very valuable contribution, Iron in all Ages, to the history of the manufacture of iron and steel. I am also under obligation to E. C. Potter, Second Vice-President of the Illinois Steel Company, for engravings and photographs of parts of the very extensive works of that company. John Thomas, Superintendent of the Thomas Iron Company, Hokendauqua, Pennsylvania, has kindly furnished me with some interesting facts relative to the first anthracite blast-furnace; and from J.

The first mention of the existence of iron-ore on this continent was by Thomas Harriot, "the geographer" of the second expedition to Virginia. This expedition effected a settlement on Roanoke Island, and Harriot in his history of the colony says: "In two places of the countrey specially, one about foure score and the other six score miles from the fort or place where wee dwelt, wee founde neere the water side the ground to be rockie, which, by the triall of a minerall man was founde to hold iron richly. It is founde in manie places of the countrey else. I know nothing to the contrarie but that it maie bee allowed for a good marchantable commoditie, considering there the small charge for the labour and feeding of men; the infinite store of wood; the want of wood and the deerenesse thereof in England; and the necessity of balasting of shippes." Nothing seems to have come of this discovery; and the colony, being menaced by the Indians, became discouraged and returned to England in 1586.

We next read of American iron-ore in the history of the colony which located at Jamestown, Virginia, in 1607. We are told that "on the 10th of April, 1608, the company's ship sailed from Jamestown, loaded with iron ore, sassafras, cedar posts, and walnut boards." Seventeen tons of iron made from this ore in England was sold to the East India Company for £4 per ton. This was without doubt the first sale of iron made from American ores. An attempt was made in the years 1620 to 1622 to erect iron-works on Falling Creek, a branch of the James River, about sixty-six miles above Jamestown, but on the 10th of March, 1622, the buildings were burned by the Indians and 347 persons were killed; thus ending in fire and blood the first attempt to make iron on a manufacturing scale on this continent.

We have no account of the actual form of the furnaces or other apparatus, nor any description of the methods of smelting employed in the earliest iron-works of this country, but from the evidence accessible we are quite safe in assuming that the early American metallurgists were in no great degree wiser than their European instructors; and, when we consider the difficulties of every kind that must have surrounded all attempts to manufacture iron in a new country, it seems highly probable that our early iron masters would have adopted the simplest and most inexpensive methods known to be capable of accomplishing the desired

Vaughan Merrick and James Moore, of Philadelphia, I have received information in regard to the early use of the Nasmyth steam hammer in the United States. I am also indebted to Oliver Williams, Esq., President of the Catasauqua Manufacturing Company, of Catasauqua, Pennsylvania, for information relative to the manufacture of anthracite iron at that place. I also acknowledge with pleasure the kind offices of W. H. Wahl, Ph. D., Secretary of the Franklin Institute, and James Gayley, Esq., Superintendent of Furnaces at the Edgar Thomson Steel Works.

result, and, as fuel and ore were abundant, it is not likely that economy would be much studied in their use.

The simplest process known for obtaining iron from its ore can be carried out in an ordinary blacksmith's fire by throwing crushed ore upon the ignited fuel, covering it with coal, and, after urging the fire with bellows for a considerable time, there will be found in the bottom of the fire an irregular mass of forgeable metal. Some form of this process is still employed by many savage and semi-civilized people; and this was doubtless the method used by the "mineral man" in testing the ores of iron discovered by the Roanoke colonists in 1585.

In Fig. 1 is shown a modification of this process, practiced by the iron-workers of Persia and adjacent countries, who have

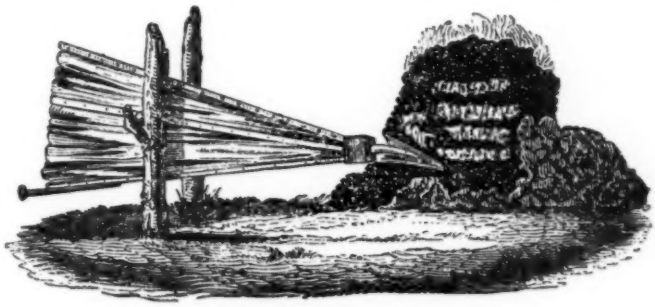

FIG. 1.—PERSIAN METHOD OF SMELTING IRON.

manufactured both iron and steel by this simple and inexpensive method (as measured by their standards of the value of time, labor, and material), from the days of Tubal-Cain to the present time, and have fabricated therefrom cutting tools and weapons of unsurpassed excellence. The keenness of edge, wonderful temper, and marvelous elasticity of the swords of Damascus have had a world-wide fame for thousands of years. George Thompson, the distinguished English orator and philanthropist, stated that "when in Calcutta, he saw a man throw in the air a handful of floss silk, which a Hindoo cut in pieces with his saber. Many of the swords and daggers made in central and western Asia two thousand years ago were as remarkable for their elaborate finish and exquisite ornamentation as for their more practical qualities.

The process, illustrated by Fig. 1, was substantially as follows: A basin-shaped hole, six to twelve inches in depth and twelve to twenty-four inches in diameter, was first made in the earth; this cavity was then lined with moistened charcoal dust, which was well rammed to make it as dense as possible; the hearth thus formed was then filled with charcoal, on which was placed a layer of crushed ore, and over this alternate layers of fuel and ore until

the heap was of the desired height; the outside of the mass of charcoal and ore was then incased in a covering of rough stones laid in a mortar of clay and sand, or, in some cases, it was merely plastered over with a thick layer of such mortar; care was always taken to have a hole near the bottom, just above the edge of the hearth, for the insertion of a tube of baked clay to serve as a *tuyère*, and a second hole at the top for the escape of smoke and gases. Fire was then introduced at the *tuyère* and the bellows connected; a gentle blast being used until all the moisture in the ore and the covering of the heap was driven off. As soon as this was accomplished, the blast was increased and the heat thereby augmented. At the end of several hours a mass of metallic iron, weighing twenty or thirty pounds, was found in the bottom of the hearth, from which it was removed by tongs and forged by sledge-hammers into the desired shape, several reheatings being required. The iron obtained was not usually over twenty per cent of that in the ore, and only the richest ores were used.

The first attempts to smelt iron-ore were probably made in open, or perhaps partially inclosed, fires, in which the operation was conducted without the stimulus of a blast; but the slow and very irregular burning of the fuel during calms, as compared with its more rapid and effective combustion when urged by a high wind, must have soon suggested the desirability of a regular and manageable method of supplying the primitive furnaces with a current of air, and we find that the use of some contrivance for this purpose is of great antiquity.

Bellows are known to have been used by the Egyptians over three thousand years ago. They consisted of a pair of leather bags (which were nearly spherical when inflated), to each of which was attached a tube for the discharge of the air.* The operator stood with a foot on each of these bags, and pressed them alternately by throwing his weight from one foot to the other. In the top of each bag was a round hole, which could be closed by the foot of the workman, and a cord held in each hand enabled him to distend and inflate either bag as he compressed the other. His feet served as valves to prevent the escape of air from the holes, and compelled it to pass through the discharge-pipe into the fire.

Piston bellows were known in Egypt at least two thousand years ago, and compressed air was used for various purposes other than blowing fires. The kind of bellows shown in Fig. 1 was known and used by the Greeks and Romans at a very early period, and the bellows of our kitchens are of equal antiquity. Bellows

* Perhaps the expression "a pair of bellows," which in the days of "open hearth" practice in our older kitchens was quite common, had its origin in an equivalent Egyptian colloquialism.

constructed as shown in Figs. 3 and 15, were invented in Germany in the latter part of the sixteenth century; the exact date, as well as the inventor's name, is uncertain. Bellows working on the principle of those used in accordions and concertinas have also been known for many centuries. An engraving, showing such bellows in use blowing a furnace, is given in the great work of Agricola,* who also illustated rotary fan-blowers; but these evidently did not propel the air centrifugally, as does the modern fan-blower, but pushed the air forward, very much as a revolving paddle-wheel pushes water.

Another very curious apparatus for blowing furnaces and smiths' fires is called a *trompe*. It consists of a vertical pipe, usually made of wood, of a length suited to the fall of water. Near the top of this pipe there are pierced a number of comparatively small lateral openings which incline downward in their passage through the thickness of the sides of the pipe, whose lower end enters the closed top of a barrel or other air-tight vessel, from which proceeds a tube to convey the air to the furnace or forge. This contrivance operates as follows: The descending column of water in the pipe draws in air through the lateral openings near its top, and this air is carried down by the water and separates from it in the interior of the barrel and then passes to the forge by the discharge-pipe, the water escaping through a hole at or near the bottom of the barrel. Percy,† speaking of this very simple blowing apparatus, says, "It is said that it was invented in Italy in 1640." But it must have originated at a much earlier date, as Branca‡ gives three applications of it, illustrated by engravings, and it is very probable that this highly ingenious method of employing the fall of water to compress air was known and used hundreds of years before the time of Branca.

The early American forges and furnaces were blown either by the ordinary leather bellows (Fig. 1), or by wooden cylinders called "blowing-tubs," or by the *trompe* just described, and there are still to be found in use a few examples of each of these primitive methods of "raising the wind." In Fig. 2 we have an illustration of a pair of "blowing-tubs" such as Overman§ describes as "the best form of wooden blast-machine." The figure shows a vertical section through the axes of the upright "blowing-tubs," *a a*, and the "wind-chest," *b*, placed immediately above them. Air enters the tubs from beneath and is pumped by the pistons *d d*, with the aid of the "clack-valves" shown in the figure, into the wind-chest. The pressure of the air in the wind-chest is determined by the weight *h* suspended at the lower end

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* De Re Metallica, Basilæ, 1546.

† Metallurgy, Iron and Steel, London, 1864.

‡ Le Machine, Roma, 1629.

§ The Manufacture of Iron, Philadelphia, 1850.

of the rod attached to the piston *g*, which rises and falls as the volume of air beneath it varies in accordance with the demands of the furnace or the slight irregularities of supply. The air was conveyed to the furnace through a metal pipe, *c*, connected with the wooden bottom of the wind-chest by a flanged elbow. Blowing-tubs of a square cross-section with corresponding pis-

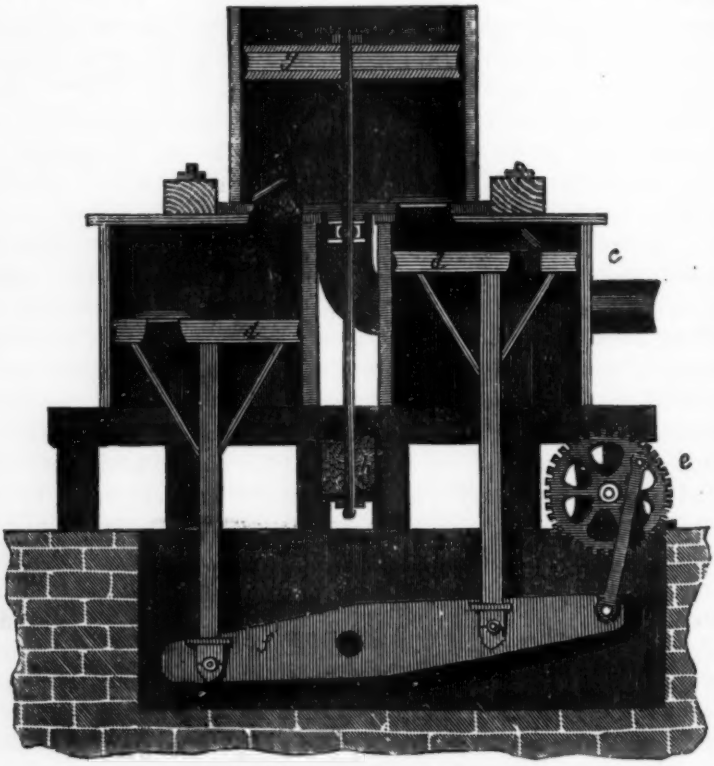

FIG. 2.—A PAIR OF BLOWING-TUBS.

tons have been used with success, and as late as 1873 three such machines were in use in Detroit for furnishing blast to a large cupola; and, notwithstanding the primitive construction of this blowing apparatus, the melting was quite as satisfactory and economical as the best of the present day.*

Having now described the various forms of apparatus for blowing furnaces and forges in use at the beginning of the seventeenth century, we will again turn our attention to the progress of the manufacture of iron in America. The first iron-works built in this country that are entitled to be called successful

* The average record of the cupola blown by these square wooden "blowing-tubs" was eleven pounds of metal melted by one pound of fuel. Very few cupolas now in use do as well, and by far the greater number are not more than half as economical.—W. F. D.

were erected in the Province of Massachusetts Bay, in what is now the town of Saugus, a suburb of the city of Lynn, about ten miles northeast of Boston. Their owners, "The Company of Undertakers for the Iron-works," were granted a number of special privileges, among which was the monopoly of the manufacture for twenty-one years. The works appear to have been commenced late in the year 1643 or in the beginning of 1644, and were nearly completed in 1645, as on the 14th day of May in that year the General Court passed a "Resolve," declaring that "y^e^ iron-works is very successful (both in y^e^ richness of y^e^ ore and y^e^ goodness of y^e^ iron)," and that "y^e^ furnace is built, with that which belongeth to it, . . . and some tuns of sowe iron cast . . . in readiness for y^e^ forge." On the 14th of October of that year the General Court granted still further privileges on the condition "that the inhabitants of this jurisdiction be furnished with barr iron of all sorts for their use, not exceeding twentye pounds per tunn," and that the land already granted be used "for the building and seting up of six forges, or furnaces, and not bloomaries onely," and the company was confirmed in the right to the free use of all materials "for making or moulding any manner of gunnes, potts, and all other cast-iron ware."

On the 6th of May, 1646, Richard Leader, the general agent of the company, purchased "some of the country's gunnes to melt over at the foundery." This statement seems to justify the belief that there may have been a reverberatory furnace in this "foundery," as such furnaces were well known in Europe at that date, and castings of all sorts were made from metal melted in them; but it is certain that, at the same period, castings were frequently made from iron taken direct from the blast-furnace, and we know that scrap cast iron can be melted in a blast-furnace without difficulty. The cupola furnace, for remelting "pig iron" and scrap cast iron, was not invented until 1790, and, consequently, we are sure that it was not employed in the "foundery" at Lynn in 1646. Hence it is evident that the "gunnes" purchased must have been remelted in the "blast-furnace," or in a reverberatory furnace, although we have no decisive evidence of the employment of the latter type of furnace.

It is certain that at Lynn, in the Province of Massachusetts Bay, was cast, in the year 1645, the first piece of hollow ware made in America—"a small iron pot capable of containing about one quart." * This pioneer of all American-made castings was in existence in 1844, but recent efforts † to ascertain its whereabouts have been unsuccessful. The works at Lynn appear to have been very prosperous for a number of years; but after a time they

* Lewis's History of Lynn, 1844.

† By C. H. J. Woodbury, Esq., of Lynn.

became unpopular, owing to the flowage of lands by their dam, and the great destruction of timber for fuel.

The Rev. William Hubbard, writing in 1677,* says they were "strenuously carried on for some time, but at length, instead of drawing out bars of iron for the country's use, there was hammered out nothing but contentions and lawsuits." Just about this time Samuel Butler was writing his great poem in which he makes Hudibras say:

> Alas! what perils do environ
> The man who meddles with cold iron!—

a reflection which has been sadly appropriate in the case of too many American iron-works.

After the establishment of this first successful "furnace" and "foundery" at Lynn, works for the manufacture of iron were erected in other parts of New England, and thence-the business spread into New York, New Jersey, Pennsylvania, and Maryland. During the "French War" (1755) there were a number of furnaces in operation at which "cannon, bombs, and bullets" were made in great quantity, and many of these iron-works furnished similar supplies to the Continental army during the Revolution.

It is a matter of profound regret that no drawings of the early iron-works erected in this country have been preserved; and we are therefore compelled to form our ideas of their construction from such meager verbal descriptions as are given by writers of the time, combined with illustrations of furnaces and processes for the manufacture of iron known to have been used at or near the same period in Europe. The iron-works at Lynn seem to have embraced a "blast-furnace," a "foundry," and a forge. The product of the furnace was in part made into "sowe iron," and the remainder used in "y^{e} foundery," for the manufacture of hollow ware and other castings. In "y^{e} forge," the sow iron† was converted into "all sorts of barr iron." The blast-furnaces in use in Germany at that time were from twenty to twenty-five feet high, and had boshes, and openings at several heights for the purpose of tapping out the cinder. In the Philosophical Transactions for 1676, Henry Powle, describing the furnaces then in operation in the Forest of Dean, in Gloucestershire, England, says: "The blast-furnaces are about twenty-four feet square on the outside, nearly thirty feet high, and eight or ten feet wide at the boshes. Behind the furnace are placed two huge pair of bellows, whose noses meet at a little hole near the bottom.

* The Present State of New England, 1677.

† "Sowe iron" was an elongated mass of cast iron, tapering at each end, and having a triangular cross-section; it was often twenty feet in length, and weighed from twelve to fifteen hundred pounds. It was made by running the fluid iron from the furnace into a trench in sand, where it solidified.

These are compressed together by certain buttons, placed on the axis of a very large wheel, which is turn'd about by water in the manner of an overshot mill. As soon as these buttons are slid off, the bellows are raised again by the counter-poise of weights, whereby they are made to play alternately, the one giving its blast all the time the other is rising."

Fig. 3 * is a vertical section of a blast-furnace, such as had been used for some years in Sweden prior to 1734; and it may be regarded as representative of the construction of furnace that had been employed in Germany, France, and England for the previous hundred years, and in all probability for a much longer period. The reader will readily perceive that the bellows (made of wood) were operated by what Henry Powle, above quoted, described as "certain buttons"; and in fact the construction and size of the furnace illustrated did not differ greatly from that seen by Powle. This Swedish furnace was fifteen feet square outside, and twenty-nine feet high; its internal diameter at the top, D D, was four feet, and at the widest part six feet. The "boshes," or diminishing part of the furnace, O O, were made of a mixture of fire-clay and crushed quartz; the inner walls, M M, were of sandstone laid in regular courses, while the outer walls, G G, were made of any convenient coarse, rough stone laid in lime mortar; the space, F F, between the inner and outer walls, was filled with cinder, small stones, and other similar material. The hearth, C, was about two feet square. The top of the furnace was surmounted by a parapet, H, of rough-hewn logs. Comparing the construction of this furnace with the earlier practice, Swedenborg says:

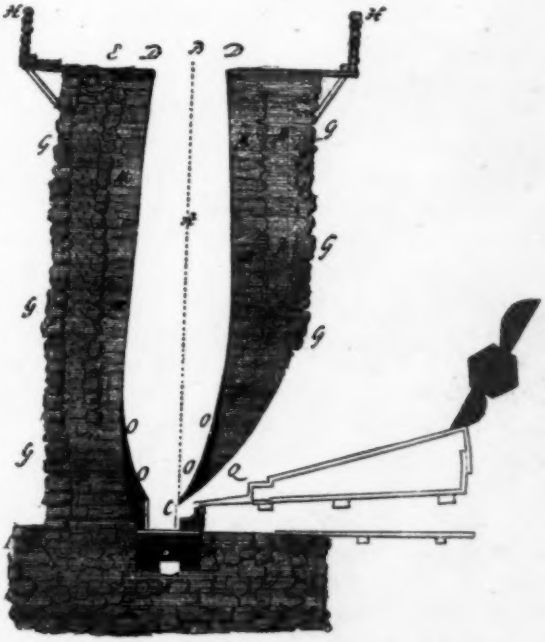

FIG. 3.—VERTICAL SECTION OF A BLAST-FURNACE OF THE SEVENTEENTH AND EIGHTEENTH CENTURIES.

* From De Ferro, by Emanuel Swedenborg, 1734.

"Formerly furnaces were constructed much simpler, and no specific or exact proportions were observed; and it was not considered necessary that the walls should have any fixed dimensions, either as to thickness or height; but (according to Agricola, who was the first to describe them) the whole structure was rude,

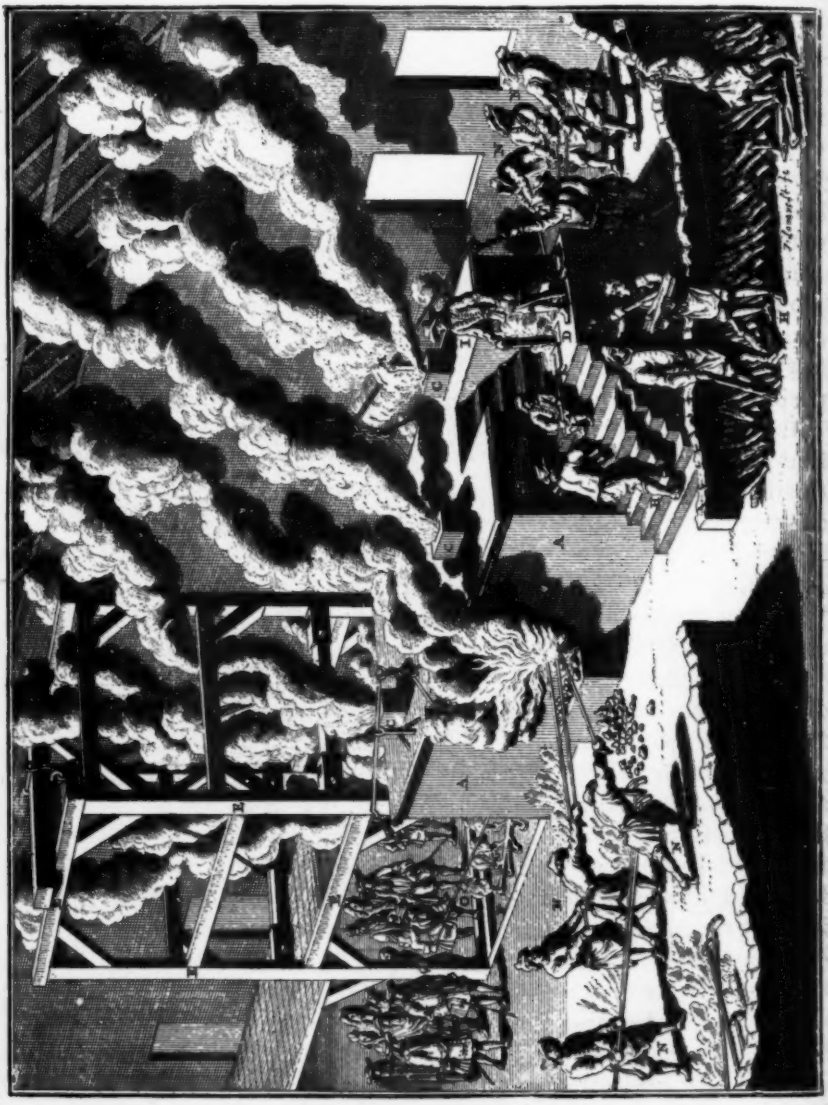

FIG. 4.—A REVERBERATORY FURNACE. (1647.)

loose, and imperfect, their daily product of iron was small, and they consumed a very large quantity of charcoal; but afterward, when it became evident that regularity in smelting insured excellence of product, and at the same time the realization of

greater profit, then more perfect plans were made, and higher furnaces, having greater capacity and more solid walls, were constructed."

The reverberatory furnace had been employed in Europe from the earliest times for the melting of brass and other metals; and for heating them dry wood was the usual fuel. Benvenuto Cellini (about 1547) erected such a furnace for melting the bronze for his statue of Perseus; and he expressly states that he commenced the melting with "pine wood, which, because of the oiliness of the resinous matter that oozes from the pine tree, and that my furnace was admirably well made, burned at such a rate, that I was continually obliged to run to and fro, which greatly fatigued me"; and, after describing various troubles in getting the metal melted, he finally completes that operation by the use of "a load of young oak, which had been above a year in drying."

From a French work on the construction of artillery * we take Fig. 4, which is a very spirited illustration of a reverberatory furnace at the moment when the metal is being tapped into the molds. In this figure A is the furnace; B, the furnace-doors, which are made of iron; C, chimneys of the furnace; D, fire-hole; E, frame of carpentry above the pit, to which is attached the pulleys and other tackle which serve to lower the molds into the pit and remove the castings made; F, pit (made in the earth), in which the molds are placed; G, "runners" with "gates" for the metal; H, workmen who split the wood and carry it to the furnace; I, workman who throws the wood into the fire: the wood falls upon a grate which is at the bottom of the fire-box, three feet or more below the part of the furnace containing the metal; K, cover, or paddle of iron, for closing the mouth of the fire-box; L, workmen who raise the furnace-doors by means of a lever; M, lever for raising furnace-doors; N, workmen who stir the melted metal with poles of wood, and who remove the slag and refuse metal with tools called "rabbles"; O, the master founder, with the tapping-bar, opening the hole by which the metal is discharged into the "runners"; around him stand a group of interested visitors. After this description we are told that "the furnace at Douay contains sixty thousand pounds of metal." This would not be regarded as a small furnace even now.

FIG. 4.—A REVERBERATORY FURNACE (1647.)

As illustrating how the metal was taken from the early blast-furnaces for the making of "sowe iron" and castings of various kinds, we reproduce † Figs. 5 and 6. In Fig. 5 workmen, numbered 1 and 2, are seen making an open mold of triangular cross-section in the floor of the "foundry," in which is to be cast a sow,

* Mémoires d'Artillerie, 1647.

† From Recueil de Planches, sur les Sciences, les Arts Libéraux, et les Arts Méchaniques avec leur explications. A Paris, 1765.

and others (3 and 4) are removing, by means of levers and rollers, the sow last made. The wooden bellows which blow the furnace are shown at R, R, R. The furnace illustrated appears to have been constructed with unusual care, its walls having been

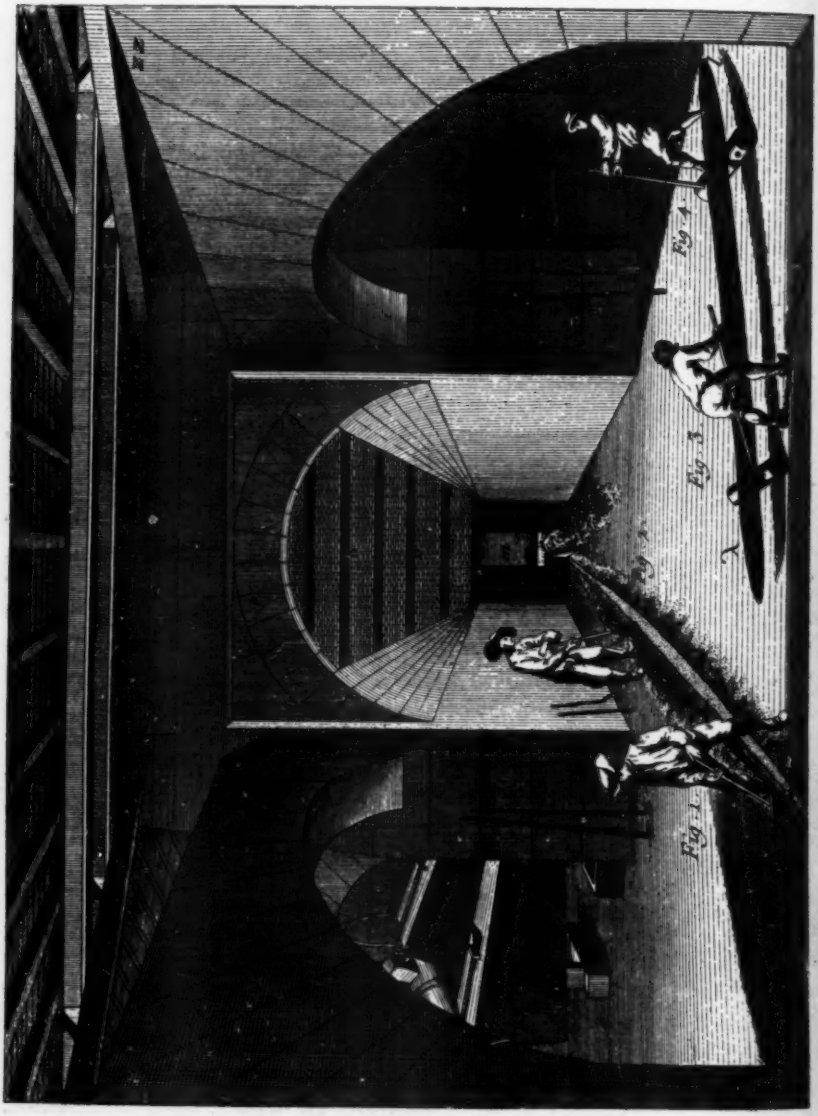

FIG. 5.—PREPARING TO CAST A SOW.

built of dressed stone laid in regular courses, strengthened at the corners by massive rampant arched buttresses, one of which is marked Z, Z. At B, B, B, are iron bearers that support the masonry of the furnace above the arch; C, C, are side stones of the hearth; D is the "tymp"; F, the "dam"; I, the "tap-hole."

In Fig. 6 we have a view of the interior of an ancient "foundry," in which the metal was taken direct from the blast-furnace and used for the making of castings. In this engraving a workman (1) is taking the metal from the hearth of the furnace over the dam F, with a ladle. Another workman (3) is "pouring" the

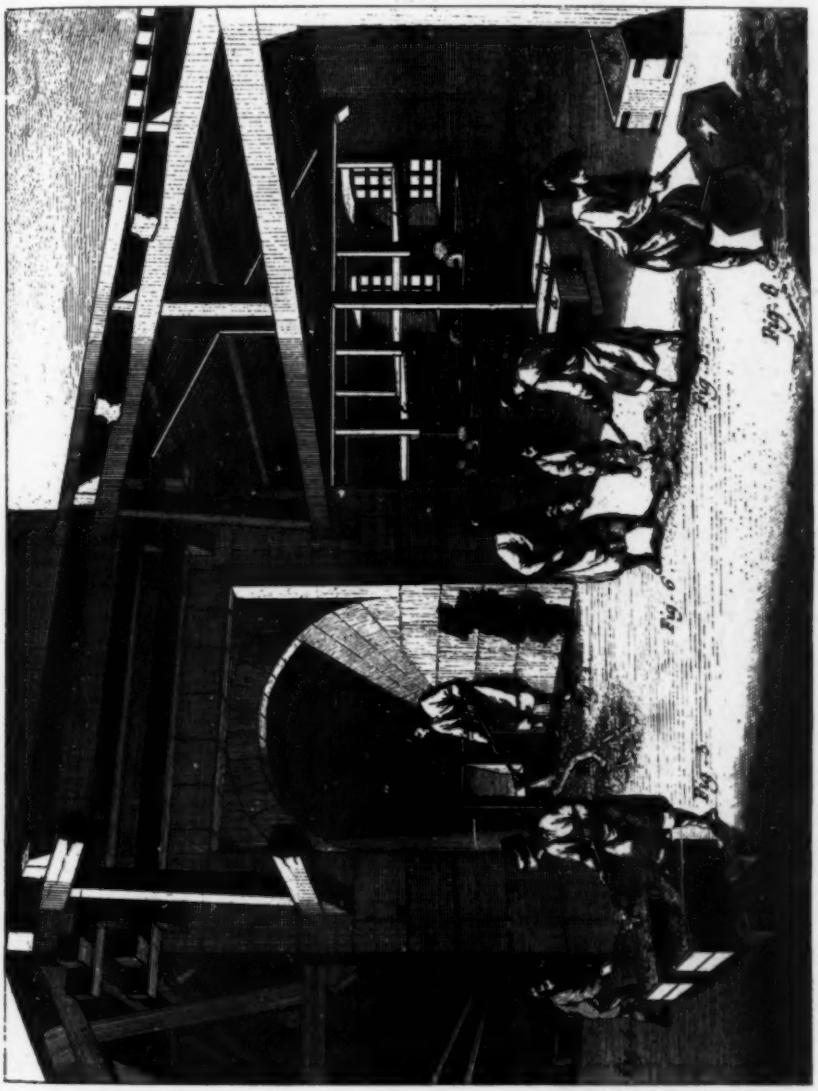

FIG. 6.—INTERIOR OF AN ANCIENT FOUNDRY.

mold *c*, with metal from a hand-ladle; while a boy (4) skims the metal and prevents slag and other floating impurities from escaping with the metal from the ladle; close at hand is another mold, *b*, ready for pouring. At 5 is a man pouring metal from a hand-ladle into the "gate," Z, of a mold that is buried in the floor of

the "foundry," while a second man (6) keeps him supplied with metal from another ladle which is skimmed by a boy (7). At 8 is a man cleaning a cast-iron pipe. Pipes made at this period were rarely over three feet in length, and were provided with polygonal flanges at each end for fastening them together with bolts. Pipes two inches in diameter had oval flanges and two bolts; three-inch pipes had triangular flanges; eight-inch pipes were square-flanged; while pipes of twelve and eighteen inches in diameter had flanges of six and eight sides respectively, the number of bolts always equaling the number of angles in the flanges.

It is not at all certain when the first castings were made from remelted sow, or other form of crude cast iron; but the crucible has been used for remelting cast iron since a very remote period, and is largely employed in China for that purpose at the present

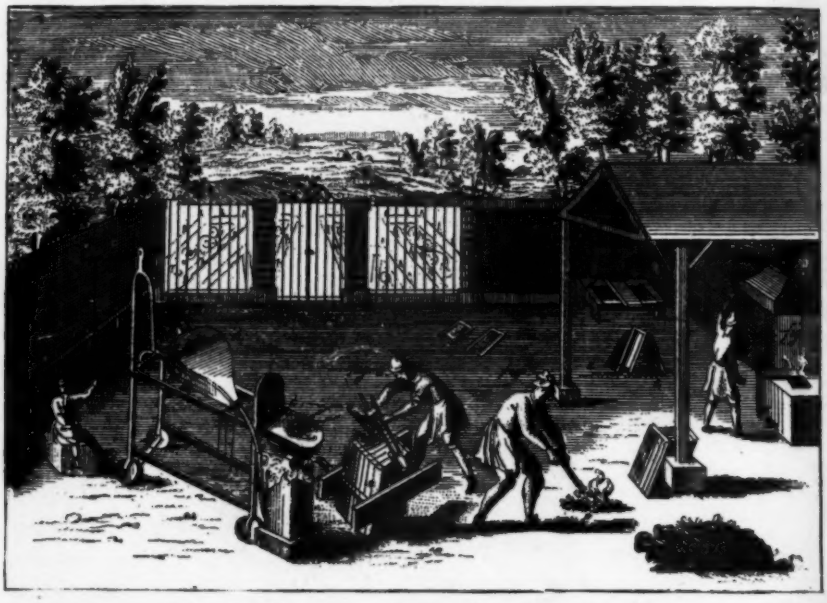

FIG. 7.—THE PROCESS OF CASTING CRUCIBLE-MELTED IRON.

day, and the culinary utensils made in that country are remarkable for their thinness. As illustrating the making of castings from crucible-melted iron, we extract Fig. 7, from Réaumur's* work. In this plate "*b* is a shed, under which is placed a furnace *c*, such as is ordinarily found in the shops of the makers of small castings. This furnace was blown by bellows, held but one crucible, and was quite similar in construction to many furnaces in use at the present day; *d d* is a box for holding the molding-

* L'art de convertir le fer forgé en Acier, et L'art d'adoucir le fer fondu. Par Monsieur de Réaumur, de l'Académie Royale des Sciences. Paris, 1722.

sand; *e e* are molds being dried. At the left is seen a small portable furnace on wheels, to which blast is supplied by the bellows *h*, of a forge. When this is used as a forge, the bellows *h* are rearranged so as to blow through an opening at the top. In the figure, 2 is a workman filling a mold with fluid metal which has been melted in the furnace. At *m* are seen the screw-clamps that confine the three molds *n*. Near the middle of the picture are two parts of a mold separated; at the right, in the foreground, is a pile of charcoal, and at *q* is a furnace (similar to a baker's oven) for drying the cores for the molds."

FIG. 8.—MELTING IRON FOR CASTING IN SMALL FURNACES.

In Fig. 8 (also taken from Réaumur's treatise) "is shown two common furnaces in which the iron to be melted is thrown among the charcoal without being placed by itself in a crucible; one of these furnaces is represented as erected, and actually melting the iron; while the other is dismounted, and the melted iron is being poured into molds. "The workmen (1 and 2) operate the bellows; *a b* is the upper part of the furnace, whose base is buried in charcoal dust; *b* is the opening into which is thrown the charcoal and pieces of iron; *c c*, the powdered charcoal which surrounds the base of the furnace; *d* is the *tuyère* which receives the noses of the bellows; *e* is a heap of charcoal; *e* 2 is a pile of fragments of cast iron; *f* is a post which supports the lever *g*, by means of which the ladle which forms the bottom of the furnace is easily raised." The workmen (3 and 4) are occupied in pouring into molds the iron which has been melted in the sec-

ond furnace, which is exactly like that already described; 3 is manœuvring the lever, to one end of which the ladle containing the melted iron is suspended; 4 holds the handle and tips the ladle, thus regulating the pouring of the metal; *i i*, the hole from which the ladle *k*, forming the base of the second furnace, was taken for pouring; *l*, the upper part of the furnace removed; *n*, mold in which the iron is being poured."

Réaumur also describes a third apparatus for melting cast iron, which consists of a furnace of similar form to that just described, but without the removable ladle bottom. This furnace was supported on "trunnions" by a carriage mounted on wheels; at a proper height above the bottom was a "tap-hole," and on the opposite side an opening, or *tuyère*, for the nose of the bellows. The iron to be melted was (as in the last furnace) mixed directly with the fuel, and when it became fluid accumulated in the bottom of the furnace; as soon as all the iron was melted, the "tap-hole" was opened and the bellows removed; the whole body of the furnace was then turned on its "trunnions," and the metal run off through the "tap-hole" into "molds" placed to receive it. This furnace was at a later period called a "calabash," and it may be regarded as the direct progenitor of the modern foundry "cupola"; and it is not more than forty years since a very similar apparatus was in use in this country for melting brass; but in this the furnace, after the metal was melted, was suspended by its "trunnions" to a crane, and, being without a "tap-hole," the metal was run into the molds by inclining the furnace sufficiently to allow it to run over the top.

The reader must not infer that the primitive lever crane, illustrated in Fig. 8, was the only form known in the early part of the last century; as, on the contrary, Agricola, more than one hundred and fifty years before, described and illustrated several cranes of much more elaborate construction, some of which are quite similar in idea to foundry cranes in common use at the present day.

As in some degree illustrative of the rude picturesqueness of all the belongings of the old type of charcoal furnace, we have engraved (Fig. 9) a view of the remains of one situated on the Conemaugh River, in western Pennsylvania. The "hot-blast stove" which surmounts the "stack" is evidence that the spirit of modern progress has wrestled with the inevitable in vain, and the broken "blast-pipes," grass-grown "stack," and luxuriant surrounding vegetation, show that the breath of igneous life has passed away forever, and that Nature is claiming her own again.

The old colonial iron-works were of necessity located in valleys where advantage could be taken of a natural fall of water, or where a stream could be dammed at small expense; and, although when measured by the standards of our time, they were very

imperfect in plan, rude in structure, uncouth and clumsy as to machinery, yet these primitive works produced metal, albeit small in quantity (eight to ten tons per week), of a quality that has never been excelled by the colossal furnaces and forges of this day and generation. The progress of improvement in those early days was slow, painful, and uncertain. Steam and Electricity, twin sons of modern civilization, were unborn, and the mechanic arts only represented what was possible to be accomplished by

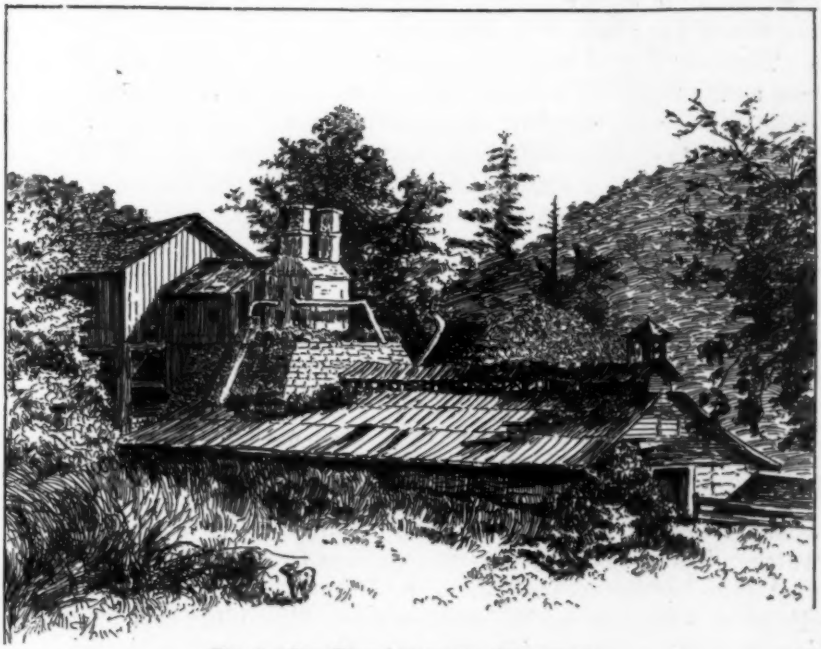

FIG. 9.—OLD FURNACE ON THE CONEMAUGH.

the skill and muscular energy of men and animals. The wonder-working mechanisms now known as "machine-tools" were unimagined, and men wrought laboriously, by dint of the acute eye, cunning hand, strong arm, and stalwart courage, at subduing the savagery of a continent.

In presence of so many obstacles, and having such plentiful lack of nearly everything that modern engineers and artisans would regard as indispensable, the failure of the pioneer American sons of Vulcan would have occasioned no surprise, and their triumphant success is therefore all the greater wonder.

Thus far we have spoken chiefly of the furnaces and apparatus used in colonial times for the production of cast iron in its three forms of "sowe iron," "pig iron,"* and "castings," and have

* Pig iron is usually in the form of roughly semi-cylindrical masses about two and one half feet in length, and weighing in the vicinity of one hundred pounds each. These

briefly alluded to the fact that the earliest known method of obtaining iron from its ores produced a forgeable and weldable metal. We now purpose to describe more fully this primitive process, and to illustrate some of the machinery by which the iron produced was wrought* into bars of various sizes and forms. The process illustrated by Fig. 1 (page 147) is with slight modifications still in use in Africa, and from iron produced in this rude way the native Kaffir blacksmiths forge the heads of such "assagais" or spears as were used with deadly effect in the last conflict of the Zulus with England.

The quantity of iron that can be obtained by this simple process as the result of a single operation is quite limited and only sufficient for the forging of implements of very moderate size; but, as mankind gradually improved the conditions of life, the necessity for larger masses of the most potential metallic factor of civilization became more and more urgent, and to meet this demand there was revealed to some receptive and executive intelligence among men † the means by which such larger masses of iron could be obtained, and the "Catalan forge" ‡ or "blomary fire"* supplied for a time the world's needs for an improved process of manufacturing wrought iron. A section of one of these "forges" or "blomary fires" is represented by Fig. 10. The cavity of the hearth *d*, in the earlier forges, was lined with fire-resisting stone (usually some variety of sandstone); but later, fire-bricks were used, and still later, iron plates, which in the more recent "blomaries" have been made hollow and kept cool by a circulation of water. The *tuyère*, *b*, was placed from seven to eight inches above the bottom of the hearth, and was contrived so that its inclination could be varied at pleasure. The blast was produced

"pigs" derive their name from being cast in the same "bed" with the "sow," in side-channels communicating with the main trench.

* The term wrought iron doubtless originated as a descriptive designation from the necessity of distinguishing iron that could be readily "wrought" or shaped as desired from "sowe" or other forms of "cast iron" which could not be "wrought" under the hammer.

† Such persons are in these days called "inventors," and are generally regarded as the originators of the various ideas and devices which they urge upon the attention of mankind; but they are, strictly speaking, simply vehicles and avenues by and through which knowledge continually comes into the world for the steady advancement of civilization. Columbus did not "invent" America, and was no more responsible for its existence than the trumpet for the note of command that issues from its resounding muzzle. This is not said in disparagement of "inventors," but only in explanation of their true function and relation to civilization. Certainly no more honorable fame, or honest wealth, can fall to any man than that which comes from being the recognized means by which beneficent knowledge is discovered; therefore all honors and rewards to such "inventors," the true prophets of science and human progress.

‡ Derives its name from the province of Catalonia, in the north of Spain, where it has been used for many centuries.

* From the Anglo-Saxon *blôma*, a mass or lump; *isenes blôma*, a mass or lump of iron.

either by the "*trompe*" or by wooden or leather bellows; and sometimes by what some writers—in utter defiance of Euclid and all his disciples—have called "square wooden cylinders," worked by rude water-wheels.

The ores most frequently reduced in these "blomary fires" were the rich magnetites containing about seventy per cent of iron, although poorer ores could be, and oftentimes were, used. Sometimes the ore was employed in the "raw state" (i. e., just as

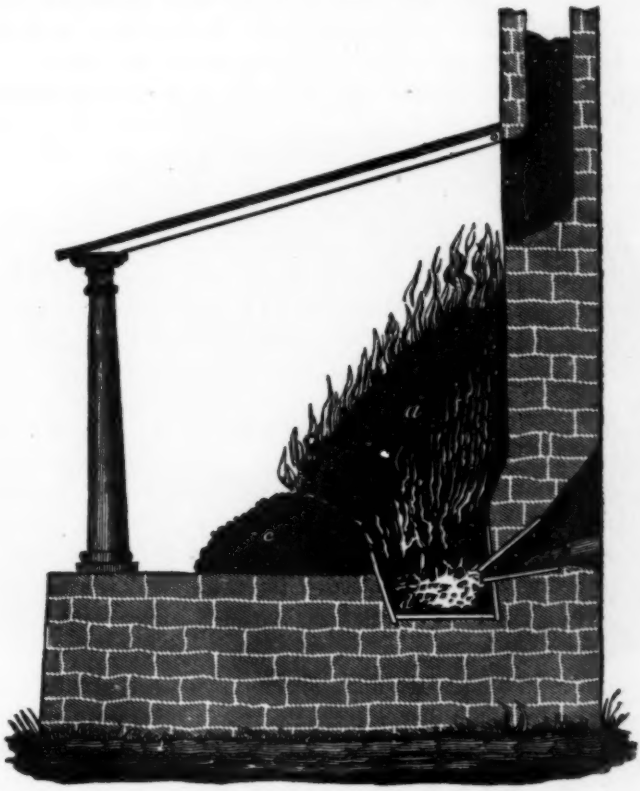

FIG. 10.—A BLOMARY FIRE.

it is taken from the mine). but the best practice was to subject it to a preliminary roasting in heaps. The operation of smelting the ore, or more properly deoxidizing it (for the metallic iron obtained in these "fires" was not the result of a true fusion), was substantially as follows, viz.: The bottom and sides of the "hearth" having been lined with a thick coating of charcoal dust, it was then filled with charcoal, upon which crushed ore was thrown, and kept in place by a dam of charcoal dust (*c*, Fig. 10). The fire was blown gently at first, and as the heat increased a more powerful blast was employed; ore and coal were

added from time to time as the work progressed, and sometimes the mass of fuel and ore was heaped up three or four feet. After an hour and a half or two hours of blowing, most of the iron in the ore was found in a pasty condition at the bottom of the hearth, in a bath of liquid "cinder" formed from the impurities of the ore and the ashes of the fuel; the blast was then augmented and most of the "cinder" drawn off through a "tap-hole" in the front side of the hearth, after which the pasty iron was lifted by bars until it was opposite or somewhat above the *tuyère*, and was there heated and manipulated until it became a spongy but coherent mass or "ball" of forgeable iron, twelve or fifteen inches in diameter, whose numerous

FIG. 11.—REMOVING A BALL FROM A CATALAN FORGE.

cavities were filled with a more or less fluid cinder. For the purpose of expelling this "cinder" and imparting greater density and coherence to the iron, the ball was then removed from the fire (Fig. 11) and taken to a "trip-hammer"* (Fig. 12) and "shingled."

The resulting "bloom," roughly cylindrical or rectangular in shape, represented about three fourths of the iron contained in the ore used; the remainder went into the cinder and was lost. The weight of the "bloom" obtained at a single operation was usually from three hundred to three hundred and fifty pounds.

* So called from the fact that it is "tripped up" and allowed to fall, by the pins on the rim of the smaller of the two wheels shown in the illustration (Fig. 12). This form of hammer is also called a "shingling hammer."

The simplicity and consequent cheapness of construction of the blomary fires caused them to be largely employed in the early years of the iron manufacture in America; and a few, that have superior advantages for obtaining supplies of ore and fuel, remain active at the present time.* We are told † that in 1731 there were in all New England "six furnaces for hollow ware and nineteen forges or blomaries for bar iron. At that time there were no furnaces for pig iron exclusively nor any refineries of pig metal; there was one slitting-mill and a manufacture of nails." In that year there were no iron-works in New York, and but a few in New Jersey (one furnace and "several forges"); in Pennsylvania there were one furnace and three "forges." At the same time there were two "furnaces" and one "blomary" in Delaware, and two "furnaces" and two "blomaries" in Maryland, and in Virginia there were three "blast-furnaces" and one "air furnace" (a form of reverberatory furnace), "but no forge." The fifteen "furnaces" and thirty "blomaries" above enumerated represented the growth of the iron industry of America during the eighty-six years following its birth at Lynn.

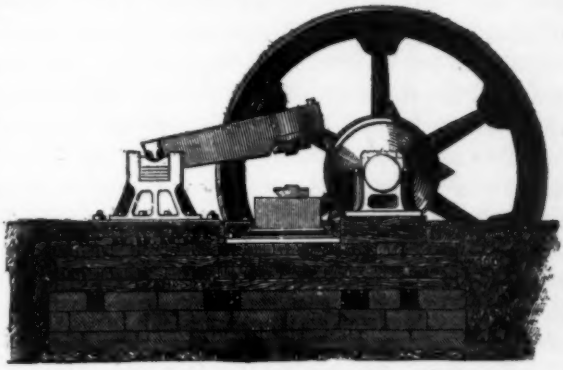

FIG. 12.—A TRIP-HAMMER.

As the result of a superabundance of painful pondering, supplemented by a proportional volume of conservative hesitation and doubt, the manufacture of iron slowly increased, not only in America, but in the world at large; and soon after the "blomary process" had been generally recognized as the most satisfactory method of making iron, the growing needs of expanding civilization began to demand some means by which the more abundant ores that were not so rich in iron as those required by

* The "Catalan forge" or "blomary fire" has been an important factor in the growth of the iron industry of the United States, but it belongs to an industrial stage of the past. In 1856 J. P. Lesley, Secretary of the American Iron Association, reported two hundred and four blomaries in active work (in nine States), whose product for that year was 28,633 tons: many of these works must have been idle, as the product seems a very low one, averaging but one hundred and forty tons each. In 1889 James M. Swank, Vice-President and General Manager of the American Iron and Steel Association, reports but five forges (four in New York and one in Tennessee), producing iron direct from the ore; their united product being 12,407 net tons of blooms.

† Bishop's History of American Manufactures.

the "blomary fires" could be easily and cheaply smelted, and at the same time furnish larger masses of forgeable metal than the process in common use could supply.

This demand led to the invention of the "Osmund* furnace" and the "Stücköfen."† Both of these furnaces are of German origin, but it is not absolutely certain which is the older; for, although we hear of the "Stücköfen" as early as the year 1000, we find no mention of the "Osmund furnace" (by that name) until early in the eighteenth century, though furnaces of similar size and construction (called "Blaseofen" and Bauernofen) had been in use in Germany for several hundred years; and as the natural course of development of all mechanisms and apparatus is from the smaller to the larger, or from the less to the more efficient, it is extremely probable that the "Osmund furnace" was the immediate successor of the "blomary" and that the "Stückofen" (a much larger and loftier construction) followed pretty closely in point of time after it.

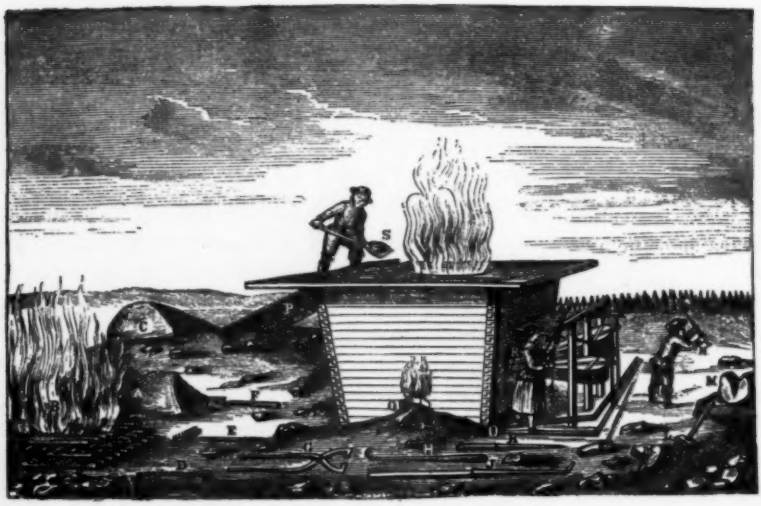

FIG. 13.—AN OSMUND FURNACE.

The general construction and equipment of an "Osmund furnace" are represented in Fig. 13. This engraving is a copy of one given by Percy‡ as a reproduction of a drawing accompanying a report of a Swedish mining surveyor to the Royal Board of Iron Trade in 1732. A similar engraving (but three times the size) is contained in the work of Swedenborg, who gives in addition a

* From the German "*Ose*," ring, and "*Mund*," mouth.

† From the German "*Stück*," bloom (piece), and "*Ofen*," furnace.

‡ Metallurgy of Iron and Steel. By John Percy, M. D., F. R. S. London, 1864, p. 321.

vertical section of the furnace, which is also copied by Percy, and which we present in Fig. 14.

In Fig. 13, A is a heap of uncalcined bog-ore; B, a calcining fire of wood on which the ore is "roasted"; C, a heap of calcined bog-ore; D, earth-borer, used to search for ores; E, charcoal-rake; F, iron shovel; G, tongs for drawing the "bloom" from the hearth of the furnace; H, cinder-hook, also used in handling the bloom; K, bar, used for clearing the cinder-notch and *tuyère;* L, large sledge for hammering the "bloom"; M M, the lump of iron; N, the hatchet; O, the treadles for working the bellows; P, bridge of planks; Q, tap-hole for cinder; R, *tuyère;* S, wooden shovel for filling ore into the furnace. It will be noticed that the

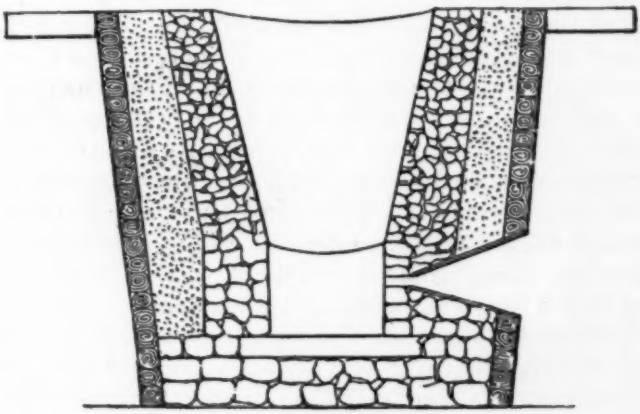

FIG. 14.—VERTICAL SECTION OF AN OSMUND FURNACE.

masonry of the furnace is incased by timber-work, which is locked together at the angles. This construction, rude and unsatisfactory as it appears to eyes familiar with the iron-bound furnace-stacks of the present day, was a not uncommon one as applied to the earlier blast-furnaces in this country; and those in which it was employed were called "log-furnaces," to distinguish them from furnaces whose exterior walls were entirely of masonry. The bellows, in the case of the Osmund furnace illustrated, appear to have been operated by a woman, who, by stepping first on one of the treadles and then on the other, thus raised by her weight the bellows boards alternately; while at the same time her nimble fingers were busy with distaff and spindle. We think we are entirely safe in saying that this method of blowing a furnace was never employed in America.

It is not certain that the Osmund furnace was ever used in this country, as we find no mention of any furnace having been erected called by that name; but, when we consider its simplicity and consequent cheapness of construction, and that it was (accord-

ing to Swedenborg) especially adapted to the working of bog-ores, large quantities of which were actually smelted in New England, it does not seem at all improbable that furnaces of similar form may have been used there for smelting such ores; and the fact that this furnace produced wrought iron in masses of considerable weight would make it of especial utility in connection with forges, which were quite numerous in the New England colonies at the beginning of the eighteenth century.

The Stücköfen was an enlargement upward of the Osmund furnace, and may be pretty accurately described, as one Osmund furnace inverted upon another, its interior form being that of two cones united at their bases, a hearth similar to that of an Osmund furnace being formed at the lower part. We have no certain information that the Stücköfen was ever used in this country; but as this furnace was well known in Europe, where it had been in use for several centuries, those interested in the earlier smelting enterprises in the American colonies must have been acquainted with its construction, and it is very probable that some of the earlier blast-furnaces were Stücköfens under another name. The fact that this furnace could be so worked as to produce either cast or wrought iron, as desired, would make it especially valuable in a new country, where there was not sufficient demand for either metal to keep a furnace constantly employed. Besides those already enumerated, there was another method of producing a "bloom" of forgeable iron; viz., by the remelting of "sowe" or "pig" iron in a "Catalan forge" or "blomary fire." In colonial times this operation was largely used and was often described as "refining," and the premises in which it was carried on were frequently called a "refinery"; but the reader must not confound this term with that applied to a comparatively modern apparatus of quite different construction and purpose, which we will describe later.

This old refining process * consisted substantially of melting the pig iron with charcoal, and then directing the blast upon the melted iron—which was stirred occasionally by proper iron tools—until its impurities in a great degree were expelled, and a spongy mass of forgeable iron was formed (quite similar, in fact, to that obtained when ore alone was used), which could be hammered into a "bloom."

Thus far we have confined ourselves mainly to a description of methods and apparatus for the production of "sowe" or "pig" iron and "blooms," which were either in actual use in America

* This process is even now worked to a limited extent, but its use is steadily declining. Mr. Swank reports that "the production of blooms and billets from pig and scrap iron in 1889 was 23,853 net tons, against 25,787 tons in 1888, and 28,218 tons in 1887."

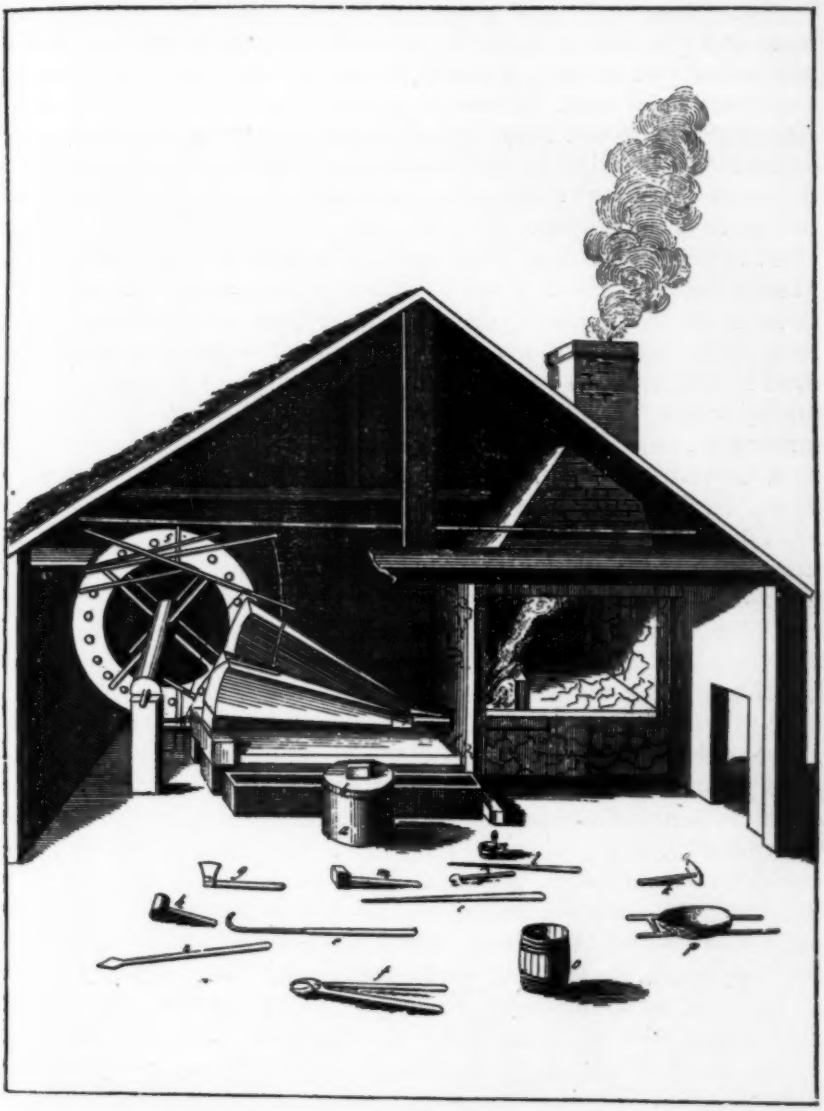

FIG. 15.—A FORGE IN 1734.

during the century following the erection of the first iron-works at Lynn, in 1645, or were coeval therewith. We now purpose to describe the early ways and means, and some of the more important improvements thereon, by which "blooms" produced by either of the before-mentioned methods were shaped into bars and rods of various forms and dimensions. The simplest means used for this purpose consisted of a hammer wielded by the muscular energy of a blacksmith.

The "hammer" was undoubtedly the first tool invented by man, and it is still not only the simplest but positively the most important tool in use; without its pioneering blows other tools could not have been fashioned, and the materials of which they are composed would have lain dormant in the earth's crust forever; for the ringing of anvils under the beating of hammers was the absolutely essential overture to the grand opera of the civilization of the human race.

If it was intended that the metal be drawn out on an anvil by "hand-hammers" and "sledges," the soft mass of iron, as it was taken from the "blomary-fire" or other furnace in which it was reduced from the ore, was cut by means of a hatchet (as shown at M N, Fig. 13) into parts not too cumbrous to be handled by ordinary smiths' tools; these pieces were then heated in a fire of larger size, blown by more powerful bellows than were commonly used by a blacksmith. One of these enlarged smiths' fires is shown in Fig. 15 (taken from Swedenborg's De Ferro), and the tools used are shown scattered about the floor. It will be noted that there are two bellows, and that these are operated by a water-wheel.

When, as was usually the case, the purpose was to make from the iron bars and rods for the general purposes of trade, the bloom resulting from shingling (as before described) the spongy mass of crude iron was reheated and drawn into the desired shape under the blows of a ponderous piece of machinery called a trip-hammer. This, although of the same name, was quite different in construction from that already described as having been used for shingling the crude iron. One of these forge trip-hammers is shown in Fig. 16, in which H is the head of the hammer; this was sometimes made of wrought iron, but more often was cast of the proper form and provided with an aperture through which the wooden beam forming the "helve" was passed and secured by wedges. W is the anvil, and *a* the "bloom," whose movements are guided and controlled by the "hammer-man" (3); while his assistant (2) determines the rapidity and force of the blows, by varying the amount of water supplied to the water-wheel which actuates the hammer. The clumsy, heavily iron-hooped, wooden shaft Y, of the water-wheel, was in this instance placed parallel with the helve of the hammer. Fastened in the circumference of this shaft were a number of round wooden pins, which, as they successively came in contact with the under side of the helve, forcibly threw it up against the spring-beam, 13, whose recoil increased the velocity of descent of the hammer and consequently the force of the blow.

Unless the bars made were of very great thickness, only a part of the bloom could be drawn out before it became too cold

to be hammered; in which case the bar, with that portion of the bloom which adhered to it, was taken to a fire and reheated; sometimes several of these reheatings were necessary before the

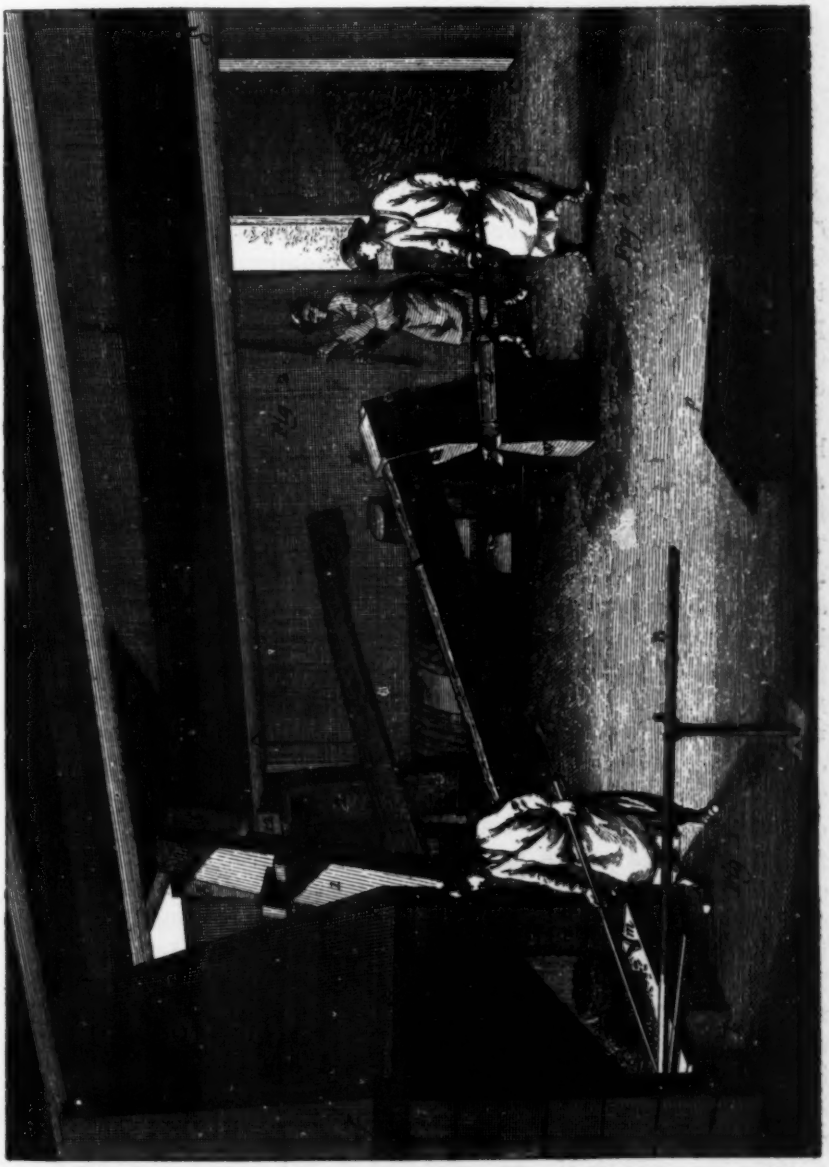

FIG. 16.—A FORGE TRIP-HAMMER.

whole of the bloom was forged into a bar. At 1 (Fig. 16) is seen a bar, B, whose end is being reheated as described. Whenever it was desired to make round bars, the hammer was provided with a groove of nearly semicircular section, located on one side

of the middle of its striking surface or "face"; and the anvil had a corresponding groove; the "bloom" was first drawn down on the plain part of the anvil to a square section, and then this square bar was rounded in the grooves of hammer and anvil.

[*To be continued.*]

WHAT SHALL WE DO WITH THE "DAGO"?

By APPLETON MORGAN.

THE very recent murder of David C. Hennessey, chief of police of the city of New Orleans, appears to direct public attention to a class of immigrants which has recently sought the hospitable ports of the United States, and, in connection with the constant questions of prison reform and prison economics, to justify a considerable and serious public attention.

The newspaper paragraph which tells what the man to be hanged at ten o'clock had for breakfast at eight, is doubtless appetizing to thousands of honest wage-workers who can not recall sitting down in all their lives to as sumptuous a bill of fare. The libraries of standard fiction provided for incarcerated felons are well enough; though, if the incarcerated felons, when liberated, are at once to take their position as leaders in progress and increasers of the public wealth, they might better be supplanted, perhaps, with works on mechanics and the mechanical motors, steam, electricity, etc. The point in civilization to which the world has arrived renders it impossible that the inmates of prisons should be starved, frozen, or tortured into imbecility. But the question as to how tenderly they should be treated, how delicately cared for, and how comfortably their bodily wants provided for, appears not yet to have been submitted to anything like a consensus of public opinion. Such question, as a matter of fact, appears to be left at large, until selected as a sentimental one for ladies and gentlemen of sympathetic natures and leisure for philanthrophies not otherwise bent; and the result is, that when anything is done it is done toward the adding of yet one more burden upon the law-abiding and uncriminal classes, to wit, the providing of increased consolations, if not luxuries, for their law-breaking and criminal brothers and sisters. When we tax the good man for the benefit of the bad man, we ought to tax him as lightly as possible. When the peaceful and useful citizen is assessed to build prisons for the house-breaker and molester of the public quiet, he doubtless should be assessed roundly enough to keep the unruly class secure from the facilities for working further mischief; and nobody will decline to go further, and say that

the prison should be clean enough and well enough drained, and wholesome enough to prevent the criminals within—their active work of evil restrained—from negatively breeding infection among the honest people they no longer affirmatively and independently rob, disturb, and destroy. There ought to be no hesitation about going quite as far as this. The question is, How much further—with an honest regard for the rights of the non-law-breaker—may we proceed? A prison is not supposed to be a nice, cozy place to live in. It should not be a desirable place even to the class of people which criminals are bred from. Neither the criminal classes—nor the classes from which criminals come—live and dress warmly; their shoes are not dry, their bodies are not well kept and sleek and cleanly; their tables are not regularly or sumptuously or even wholesomely spread. Poverty certainly should not be allowed to aggravate or in any way influence the penalty for crime: but it would seem as if, in the enforcement of the penalty, it can not be entirely left out of the estimates taken by our law-makers, and this for certain reasons, of which the following are a few:

There is just now seeking these shores, in extraordinary numbers, a class of laborers who live more meanly than the imagination of the general public, in well-paid and well-fed America, can conceive. Every one who has visited the northern shore of the Mediterranean, in Italy, is familiar with the class called *lazzaroni*. It may be actually said that this class does not live in houses at all, does not know what a house means: except for shelter against inclement weather; that it has no use for roofs at all. Water, except as it falls from the heavens, it appears to know not in any external sense; and during the long summers and mild winters a wall or an alley is quite as convenient as, and much more available a shelter than, a roof. A gang of these people, "dagoes" as they are nicknamed (a corruption of *hidalgos*, which, though a Spanish and not an Italian word, once came to be sneeringly applied to a foreigner of Latin Europe out of his element), employed in building an American railroad, will find it necessary, in the new climate, to be provided with quarters of some sort; will herd together as tightly as they can dispose themselves, in anything which is covered by a roof, and every office of nature will be performed together in the same tumbled quarters. I once happened to witness the following incident: A small circus, with a few lions and tigers, exhibiting in a small town, near by where a railroad was being constructed, fed, as a part of its programme, these wild beasts. The bones which the beasts gnawed were left on the ground when the circus departed between two days. And the "dagoes" collected these bones and boiled them for their soup! What terrors have jails and prisons for such human beings?

What have they to lose by pilfering, assaulting, robbing, and murdering? So far as creature comforts are concerned, they live better and work about as much, have warmer clothing and better beds, in the meanest jail in the United States than they experience out of it. So far as the duration of life is concerned, they will probably live as long under a sentence of death as they do in the wretched filth they pile up around them, and in the rapid changes of our national weather. The *bric-à-brac* societies who have exhausted Ibsen, Browning, and the entire science of photography, and who are now devoting themselves to the comfort and well-being of malefactors, might possibly be in good part, were there any reasonable percentage of reformation in the ordinary penitentiary experience; if the enterprising burglar, after serving out his term, burglarized no more, or the cut-throat, released from a long penalty for his crime—as Mr. Gilbert would say—"loved to hear the little brook a-gurgling and to listen to the merry village chime"; but, as a matter of fact, he doesn't. But here is a practical problem quite in the line of refinement. Sooner or later, somebody in this country will be obliged to grapple with the problem of the "dago." Can he be kept out of jail? Can he be made a useful citizen by utilizing the leisure he spends in jails to educate him into some sort of comprehension of the new country in which he finds himself? The proposition that every jail and prison should be made reformatory as well as punitory in its character would require, one would be apt to say, some little looking into. The question as to whether states are bound to reform as well as punish, their wrong-doers, depends largely upon the wider question of the duties of a state to its citizens. The other considerations, as to whether a state should make its prisoners comfortable, should watch over their physical welfare, may be disposed of at once by citing the general propositions that, however models of what they ought to be in other respects, our jails ought to be somewhat more uncomfortable to the prisoner than the most comfortless hovel that the poverty of the habitual criminal provides; as, otherwise, there would never be a class of the community to whom a residence within prison walls would not be a change for the better. Jail soup may be thin, but let the man who loves not thin soup keep out of jail. And let the soup be not thicker than, at least, the thinnest obtainable outside. To reverse the old rhyme, in most cases "Stone walls *should* a prison make, and iron bars a cage." If flowers are to be distributed by kind-hearted ladies at Easter, let it be to the deserving who keep, rather than to the undeserving who keep not, the law of the land. Of course, these propositions are not meant to contemplate the abnormal instances of squalor and filth, which communities for their own preservation must treat with and rectify.

That question is disposed of by the Boards of Health, into whose province it would seem naturally to come.

Again, as to the duties owed by states to their citizens, two things are, or ought to be, beyond question: first, that the state should attempt the greatest good to the greatest number; and, second, that it should not discriminate against the innocent in favor of the wrong-doer. If, therefore, a state or community building a jail, is unable to provide elaborately organized and classified prisons to punish its wrong-doing citizens without taxing its honest and law-abiding citizens unduly, it would not seem to be its exact duty to do so. It should not impose unbearable or irksome burdens upon its citizens who need no reformation, for the purpose of experimenting upon those to whom reformation is desirable. It is undesirable that a prison should be so constituted or managed as to make its occupants, whether reformable or not, worse than when they entered its portals; but the tendency of human nature to retrograde rather than improve, is, probably, not less constant inside than outside of penitentiaries. So far as this tendency of human nature to retrograde can be shown to be largely enough re-enforced by non-classification of prisoners to work actual harm to the state, some classification ought to be attempted.

To argue as some of us do, for example, that the public revenue should be charged with the expense of building separate institutions for boys who, at ten years of age, have begun to burglarize, and for those who have begun to steal in broad daylight; to keep up with the legal difference between the two crimes; or that a further refinement of distinction should be made between the man who has once and the one who has twice robbed; or between the one who proposes on liberation to rob, and the one who proposes on liberation not to rob again, is not only to be impracticable, but to become absurd. To a philosophic mind this leads up to the doctrine of heredity, and the question whether the criminal classes, from generation to generation, are not always distinct, to about the same proportion, from the law-abiding class. Whether the law-abiding, industrious, and honest classes should be burdened with increased taxes to try and save the freshman criminal from becoming a sophomore, and the junior from graduation into the senior class of crime, is a question much too profound to be solved from any standpoint, especially from the standpoint of the excellent gentlemen who make speeches to the philanthropical societies—which speeches are referred to committees, whose reports are printed in unlimited pamphlets; still less from the standpoint of the pamphlets themselves.

So long as governments owe a duty to all classes of the commonwealth alike, and to no one over and above or as against an-

other, they can not be governed by sentiment, be optimists or pessimists, or theorists of any sort. They must be governed by principles. In the application of those principles they must be guarded by facts; and governments, unhappily, have no other means of being informed of facts except by statistics. If figures should happen to show that one in every four hundred citizens of a given community is a law-breaker, and that this proportion had not varied perceptibly in, say, twenty-five years, would that community be justified in erecting a system of public buildings for the sake of experimenting toward a decrease of this percentage—buildings which must be paid for out of the pockets, not of the law-breakers who pay no taxes, but of the law-observers who do? Possibly the tax-payers of the community would think not.

Nothing, of course, should be allowed to antagonize the laws of humanity, or, in a large sense, the laws of charity. But to whom is charity to be shown? Which class of the community deserves the largest charity? Is it Christian to expect the honest man, who forever pays tithes of his toil, to experiment on the reformation of the man whose ancestral traditions compel or incite him to toil not, but to break in and help himself to the fruits of the honest man's toil? Let the largest charity be meted out to all. But no charity can be meted out with equity, without some regard to deserts. It must not be forgotten, even by the charitable, that if any preference is to be shown by the commonwealth, it is for those who keep rather than those who break its statutes, and for them that observe rather than for them that ignore the unwritten laws that govern human relations. Ten minutes' inspection of the haunts of crime in a city like New York, for example, ought to convince the daintiest of *bric-à-brac* ladies and gentlemen of the danger of a too well-appointed, a too substantially fed, and a too well-libraried prison. The slums where the cold of winter alternates only with the fetid and noxious odors of summer, would, to most of us, destroy confidence at least in that homeliest of maxims, "If you don't like your jail, keep out of it." Certainly, the more we strip the penitentiary of its penances, the more stress we throw on the single element of disgrace to keep men out of jail. But the disgrace of serving a term of imprisonment is a matter which, unfortunately, partakes quite as largely of *bric-à-brac* as does the sentiment of the average prison reformer. What disgrace is a year or ten years in a prison to a nomad, a man from nowhere, who has no character to lose, who goes by as many names as he pleases and changes them as often as he likes? The problem remains. We must build prisons which, somehow or other, will be less desirable abiding-places than the slums. We can not starve prisoners, or turn them on wheels, or distort them with boots or thumb-screws. We can not freeze them nor roast them, nor feed

them with miasmatic diseases. But, all the same, we must eventually find some principle, somewhere, by the practice of which, while meting out to the wrong-doer the penalty he has earned, we shall protect the revenues as well as the peace and the safety of the community.

All this is familiar reasoning enough. But the problem seems to increase to formidable dimensions just now with the new class of which we have spoken. What shall we do with the "dago"? This "dago," it seems, not only herds, but fights. The knife with which he cuts his bread he also uses to lop off another "dago's" finger or ear, or to slash another's cheek. He quarrels over his meals; and his game, whatever it is, which he plays with pennies after his meal is over, is carried on knife at hand. More even than this, he sleeps in herds; and if a "dago" in his sleep rolls up against another "dago," the two whip out their knives and settle it there and then; and, except a grunt at being disturbed, perhaps, no notice is taken by the twenty or fifty other "dagoes" in the apartment. He is quite as familiar with the sight of human blood as with the sight of the food he eats. His women follow him like dogs, expect no better treatment than dogs, and would not have the slightest idea how to conduct themselves without a succession of blows and kicks. Blows and kicks, indeed, are too common an experience with them for notice among "dagoes." When a woman is seriously hurt, she simply keeps out of sight somewhere till she is well enough for the kicking and striking to begin over again, and no notice whatever is taken of her absence meanwhile. The disappearance is perfectly well understood, and no questions are asked. The male "dago," when sober, instinctively retreats before his employer or boss, or any other man, and has no idea of assaulting him, or indeed of addressing him, or having any relations with him except to draw his pay. But, when infuriated with liquor, he will upon any fancied occasion use the only argument which he possesses—his knife. I say the only argument, for it is inevitable experience that he will not talk; however little or however much he may understand of what is said to him, he will pretend not to understand. He has a pretty clear idea of how much money is coming to him, and manages to convey that information to his paymaster. But it is rather dangerous for the paymaster to give him much less than the amount which, in his idea, is coming to him. He will refuse to accept it, withdraw, jabber and gesticulate, and it will be well for that paymaster to be on his guard until something representing that month's wages is accepted.

Now, when (as happens constantly in the course of the grading of a railroad by great swarms of these "dagoes") three or four hundred or less of these human beings are quartered for a

month in the vicinity of some prosperous, quiet, and orderly little inland town, where the justice of the peace and the constable are farmers in the field or keepers of the country "store," or the village shoemaker and carpenter respectively—what happens? What, indeed, must happen? The "dago" will not resume work the day after his pay-day, which comes monthly. (Did it come weekly, he would not work at all, as will presently appear.) He takes his wages to the nearest village or community in which spirits, or what is called spirits, is sold. If it is not given him, he fights, is arrested, and locked up; if it is given him, he also fights, is arrested, and locked up. In either case he will be taken by the constable before the justice, and a little experience will convince these officials that the only safety for their community is to "fine" the "dago" what money he may happen to have in his pocket, for, until his money is gone, he will not return to his work. This programme is repeated month by month, until that section of the railroad is finished and the "dago" is moved to another, where another adjacent village must learn, by experience, how to protect itself precisely as did the last one. Local criminal laws seem, therefore, incompetent to deal with this "dago." He has apparently nothing to lose—and from any standpoint except his own, apparently something even to gain—by the most comfortless prison that American ingenuity can devise.

Although the argument from design has made great strides since the days of Dr. Paley's watch, there yet remains much in nature for science to explain by utilizing it. The constrictive force of the African python, for example, the aggravative energy of the New Jersey mosquito, or the tremulous force of the young ladies' Browning or Ibsen Club, for example, remain as yet to puzzle us; and possibly, on the whole, the argument may be stated as in that condition of compromise in which it appeared to the starving tramp who discovered a New England swamp full of whortleberries and rattlesnakes. Design had evidently placed the whortleberries there to save his life, but chance had dropped in the utterly purposeless rattlers. A somewhat corresponding mixture of good and evil appears to confront us in the very large importation lately of this curious people. It is to the eternal credit of King Victor Emanuel that he, first in history, utilized that class of his subjects which has been known from time immemorial as the *lazzaroni*. He put this entirely unattractive person, who till then had naught to do but accommodate himself to the weather, to work removing rock *débris* on the Mont Cenis Tunnel, and since he was, to that extent, a successful railroad man, the royal example has been followed over here, and, it can not be denied, with very considerable advantage. The dago class, by liberating a class of workmen of, say, one grade higher, has actually

added to the country's creative wealth. But, when this *lazzarone* is imported into the United States and set to grading an American railway, he is found to possess characteristics which may not have interfered with his usefulness on the Mont Cenis Tunnel, but which here become exceedingly unpractical, not to say uncomfortable: and which may, as we have shown, even prove as large a problem in our criminal, as his advent was, no doubt, a happy thought in our industrial, economy.

THE IDENTITY OF LIGHT AND ELECTRICITY.*

By HENRI HERTZ.

OUR first thought, when we speak of the relations of light and electricity, is of the electric light. That is not the subject of the present paper. The physicist thinks of the extremely delicate reciprocal actions of the two forces, such as the rotation by the current of the plane of polarization, or the variation under the influence of light of the resistance of a conductor. In these cases, however, the action is not direct, but a medium, ponderable matter, is interposed. There are other closer, more intimate relations between the two forces. It is my purpose to discuss the proposition that light is in its very essence an electrical phenomenon—whether it be the light of the sun, of a candle, or of a glow-worm. Suppress electricity in the universe, light would disappear; suppress the luminiferous ether, electric and magnetic forces would cease to act through space. This theory is not of to-day or of yesterday, but has a long and instructive history. My own experiments only mark one of the steps in its development; and it is my purpose to retrace its whole evolution, not one of its phases only. It is not easy in a matter of this kind to be clear without omitting something essential. The phenomena to be considered take place in space, in the ether itself, and are not perceptible to the touch or the hearing or the sight. Reflection and reasoning may permit us to grasp them, but it is hard to make an exact description of them. We shall endeavor, therefore, to connect them with ideas that are already known to us. We refer, therefore, first to what we already know concerning light and electricity.

We know of a certainty that light is an undulatory movement, and that the undulations are transversal; we have determined their length and their velocity; and all that follows from

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these facts is equally certain. It is, therefore, sure that all of space that is accessible to us is not void, but is filled with a substance capable of entering into vibration—the ether. But while we have clear notions of the geometrical conditions of the phenomena that occur in this matter, their physical nature is very obscure; and what we know of the properties of the substance is full of contradictions. Comparing the waves of light with those of sound, they were regarded as elastic. But only longitudinal waves have been observed in fluids, and under the conditions of matter transverse waves are impossible in them. We have been obliged, therefore, to assume that the ether acts as a solid body. But when we regard the motions of the stars and endeavor to determine their conditions, we have to affirm that ether behaves like a perfect fluid. Without endeavoring at present to explain the contradiction that presents itself here, we pass to electricity; it may throw some light on the problem.

Most of the persons who ask what electricity is have no doubts respecting its real existence, and only expect a description of the properties of the singular substance. With scientific man, the problem takes the form, Does electricity really exist? Do not electric phenomena, like the other ones, go back to properties of ether and ponderable matter? Our knowledge does not as yet permit us to answer this question affirmatively. Material electricity still has a place in our conceptions, and the old and familiar idea of two kinds attracting and repelling one another, to which are attributed actions at a distance resembling intellectual qualities, still persists in current language. This theory dated from the time when Newton's law of gravitation having been confirmed by astronomy, the idea of action at a distance without the intervention of a medium was familiar. Electric and magnetic attractions were thought to obey the same law as gravitation; and, admitting a similar action at a distance, the phenomenon was supposed to be explained in the simplest manner, and the limits of knowledge on the subject to have been reached. A different aspect was presented when in this century the reciprocal action of currents and magnets was discovered, an action infinitely variable, in which motion and time played a great part. In the necessity of increasing the number of actions at a distance to complete the theory, the simplicity which gave it its scientific probability disappeared. Simple formulas and general and elementary laws were then sought, of which Weber's law was the most important tentative. Whatever may be thought of the exactness of these essays, they formed an exceptional system and a seductive whole, a magic circle, which one could not leave after having once entered it. The road was one that could not lead to the truth. It required a fresh mind to resist the current, one

that could enter upon the study of the phenomena without preconceived opinions, and was capable of starting from what it observed, and not from what it had heard, read, or learned.

Faraday followed that course. He had heard that, in electrifying a body, something new was introduced into it; but he saw that the changes were external, and not within. He was told that the forces traversed space, but he remarked that the nature of the matter that filled the space had great influence on them. He had read that electricities existed, and that we only had to consider their properties; and yet he observed every day the effects of the forces without ever seeing the electricities themselves: in this way he reversed the proposition. The electric and magnetic forces became to him the only tangible reality, while electricity and magnetism fell to the rank of objects the existence of which is contestable. Considering these lines of forces, as he called them, independently of their cause, he regarded them under the form of states of space, tension, whorls, and currents, without occupying himself with what they might really be. He was satisfied with having established their existence, with observing their influence upon each other, their attractions for material bodies, and their propagation by the transmission of the excitation from one point of space to another. If it was objected that there could be no other state than absolute rest in empty space, he could answer: "Is space, then, empty? Does not the transmission of light force us to regard it as filled with matter? Can not the ether, which transmits the luminous waves, suffer modifications which we perceive under the form of electrical and magnetic actions? Is there not a relation between these modifications and these vibrations? Are not the luminous waves a kind of scintillation of these lines of force?" Such were the inductions and hypotheses which Faraday conceived. They were as yet only mental views; he applied himself earnestly to demonstrate them scientifically; and the relations of light, electricity, and magnetism became the favorite object of his studies.

The relation he found was not the one he sought. He continued his researches till age put an end to his labors. One of his principal questions was whether the transmission of electrical and magnetic forces is instantaneous. Is the magnetic field constituted at once to the limits of space whenever the current excites an electro-magnet? Or does the action first reach the nearer points and gradually propagate itself to the more remote ones? And is the sudden modification of the electric condition of a body felt simultaneously in identical variations, in all points of space, or is there a retardation augmented as the distance increases? In the latter case, the effect of the variation would be transmitted as a wave through space. Do such waves exist?

Faraday obtained no answer to his questions, but the solution of them is directly related to his theories. If electric waves crossing space exist, the independence of the forces that produce them is demonstrated. We know that the forces do not traverse vacua instantaneously, for we can follow their propagation each instant from one point to another. Faraday's problems can, however, be solved by very simple experiments. If they had occurred to him, his theory would have triumphed at once. The relation of light and electricity would have been so clear that it could not have escaped even a less perspicacious eye than his own.

But so simple and speedy a way was not yet open to science. The first experiments brought no solution, and the current view was inconsistent with Faraday's ideas. In affirming that electric forces could exist independent of corresponding fluids, he contradicted the theory generally received at the time. A fundamental discussion of either hypothesis promised to be only a barren speculation. How much, then, should we admire the man who had the sagacity to co-ordinate these two hypotheses, apparently so distantly separated, so that they should eventually support one another, and a theory come out of them to which it should be impossible to deny probability! This man was Clerk Maxwell, whose Mathematical Theory of Light was published in 1865. We can not study the theory without feeling that mathematical formulas have a life of their own, and that they appear sometimes more intelligent than we ourselves, and even than the master who established them, giving out more than he looked for in them. Direction was given to Maxwell's researches by the fact that magnetic forces are produced from electricity in motion, and electric forces from magnetism in motion, but the effects were not appreciable except at great velocities. The idea of velocity, therefore, enters into the relation between electricity and magnetism, and the constant determining this relation, which is always found in it, is a velocity of enormous value. The velocity of electricity had been determined by delicate researches, and found equal to that of light. A disciple of Faraday could not fail to explain this coincidence by supposing that the same ether carried the electric forces and light. Hence the most important optical constant already existed in the electrical formulas. Maxwell labored to confirm this connection between the two orders of phenomena. He extended the electrical formulas so as to make them express, along with all the known phenomena, an entire class of hypothetical facts—electrical undulations. He figured them as transversal waves, the length of which might have any value, but which propagated themselves through the ether at a constant velocity, that of light. It was then possible for Maxwell to demonstrate that there really exist in nature undulations pos-

sessing those properties, although we were not in the habit of regarding them as electrical phenomena, and gave them the name of light. If Maxwell's electrical theory was rejected, there was no more reason for accepting his views concerning light. In like manner, if it was affirmed that light is a phenomenon of an elastic nature, his theory of electricity became impossible. But when his theory was studied without prepossession with the ideas that were current, all the parts could be seen to lend one another a mutual support, like the stones of a vault, and the whole resembled a gigantic arch thrown across the unknown, and uniting two known truths.

The difficulty of the theory did not permit it at first to acquire a large number of partisans. But after its inner sense was discerned it was followed out to its ultimate consequences, and then the value of its fundamental hypotheses was tested. Experiments were at first limited to a few propositions, the accessory parts of the theory. I have compared Maxwell's system to an arch traversing an abyss of the unknown. I might add that it was some time before the abutments could be connected. It was thus put in a position where it could support itself, but the span was too wide to permit any new structure to be built upon it. To accomplish that object pillars were needed, rising from the ground, to support the middle of the arch. The demonstration of the possibility of obtaining electrical or magnetic effects directly from light would constitute one of the pillars and confirm the theory; it would have immediately established the electrical part, and indirectly the optical part of it. The completion and symmetry of the structure demanded the building of both the pillars to which we compare these principles, but one was enough to begin with. The construction of the former pillar has not yet been undertaken; but after a multitude of researches a solid base has been found for the second, with sufficiently ample foundations, on which a part of the pillar has been raised. With the co-operation of many workers it will soon reach the top of the arch and afford support to the weight of the edifice which is to be raised upon it.

I have had the privilege of taking part in this portion of the work. To this fact I owe it that I am now laying my ideas before you; and I hope that I may be excused if I try at present to direct all attention to this part of the edifice. I shall unhappily be obliged, for want of time, to omit the labors of a large number of seekers, and shall be unable to show to what extent my experiments had been prepared for by my predecessors, and how near some of them had come to a definite result.

It does not at first seem so difficult to show whether propagation of electrical or magnetic forces is or is not instantaneous; to

discharge a Leyden jar, and observe whether there is any delay in the response of an electroscope a little distance off; or to observe the needle while a remote electro-magnet is excited. But these experiments, and others like them, have been tried without any interval being determined between the cause and the effect. An upholder of Maxwell's theory understands that such failures are inevitable, and arise from the enormous rapidity of the transmission. We can only perceive the discharge of a Leyden jar, or the excitation of an electro-magnet, from a moderate distance, say, of ten metres. But light, and electricity as well, according to the theory, pass over such a space in a thirty-millionth of a second. So short an interval of time can be neither perceived nor measured directly. Furthermore, we have no signals by which to define that instant. We do not make a big chalk-mark when we want to tell off a tenth of a millimetre. It would be quite as absurd, in determining a duration of a thousandth of a second, to depend on the sound of a large bell to mark the beginning of the moment.

The time required for the discharge of a Leyden jar is, according to our common means of observation, infinitely short. That does not mean that it is not equal to the thirty-millionth of a second; and, for the present case, it would be more than a thousand times too long. But Nature furnishes us another resource. It has been long known that the Leyden discharge is not uniform, but is composed, like the sound of a bell, of a number of vibrations of partial discharges, which succeed one another at even intervals of time. Electricity is capable, then, of imitating elastic phenomena. The duration of each vibration is much less than that of the whole discharge; we might, therefore, try a vibration as a standard. Unfortunately, the shortest vibrations that have been observed are of a millionth of a second. While one of these vibrations is going on, its effect is propagated to three hundred metres; while within the limited space of a laboratory it will appear simultaneous with the vibration. Known phenomena, then, gave no aid, and it was necessary to look for another way. The difficulty was turned by applying the discovery that vibrations are produced in any conductor as well as by the discharge of the Leyden jar, and often much more rapidly. When the conductor of an electrical machine is discharged, vibrations are produced, the duration of which varies from the hundred-millionth to the millionth of a second. They are, it is true, only isolated vibrations that are extinguished rapidly—a condition unfavorable for the experiment. But success would be possible even if we could observe only two or three of the vibrations. In the same way, in acoustics, we substitute, when we want to, brief signals sounded on wood for the lengthened sounds of whistles and cords.

We now possess signals in comparison with which the thirty-

millionth of a second is no longer a short interval. But they would be of little use if we were not able to compare them at that distance of about ten metres which we have proposed to ourselves. The means employed for this purpose are very simple. We fix a conductor—for instance, a straight metallic wire, having a slight interruption at one point—at the place where we desire to perceive the signal. When the electrical field is rapidly varied, a spark appears in the conductor.

The means of observation could be pointed out only by experiment. Theoretically it was hard to imagine it. The sparks are, in fact, microscopic, being hardly a hundredth of a millimetre long, and they continue less than a millionth of a second. It is extremely hard to conceive them as visible. Yet they can be seen, in a dark room and by an eye at rest. On so light a thread is hung the success of our undertaking. We had in the beginning a number of questions to answer. Under what conditions are the vibrations strongest? We must try to secure those conditions. What form should the conductor have? The phenomena will vary as we use straight or bent wires, or conductors of other forms. The form being determined upon, of what size should our conductor be? This is not a matter of indifference, for we shall see that we can not study all the vibrations with the same conductor. There are relations between the two elements like the phenomenon of resonance in acoustics. Lastly, in how many different positions can we arrange this conductor? We shall see the sparks at times increase in intensity, or become weaker, or disappear. I can not enter into these details; they are simply accessory to the theory as a whole. They are of importance only to the operator, and are simply properties of his instrument.

What the experimenter will educe from his process will depend on his knowledge of his means of action. The study of the instrument and the answers to the questions I have just mentioned therefore formed the most considerable part of my labor. This task having been disposed of, the solution of the problem was before me.

A physicist, given a number of diapasons and resonators, will find no difficulty in demonstrating that sound is not propagated instantaneously, even in the restricted space of a room. Having set the diapason in vibration, he goes with his resonator to different parts of the room and observes the intensity of the sound. He perceives that it becomes weak in some places, and infers from this that each vibration is annulled by another of later origin, which has reached the spot by a shorter route. If less time is taken in traversing the shorter road, propagation is not instantaneous, and the question is answered. But our physicist will then show us that the points of silence succeed one another

at equal intervals, and will deduce from this the length of the wave; and, if he knows the duration of the vibrations of the diapason, he will obtain, by these data, the velocity of the sound. We operate in the same way with our electrical vibrations. The conductor in which the vibrations are made fills the part of the diapason. The circuit, interrupted at a certain point, takes the place of the resonator, and may be called the electric resonator. We remark that sparks fly out at some points in the chamber, and quiet prevails in others. We notice that the spots inactive, electrically, follow in a regular order. We deduce from this, that the propagation is not instantaneous; and we can even measure the length of the wave. We are asked whether the waves are longitudinal or transversal. Let us place our metallic wire in two different positions in the same place in the room. It indicates an electrical excitation the first time, but not the second. Nothing more is needed to decide the question. The waves are transversal. If we are asked to give the velocity of propagation, we have only to multiply the length of wave which we have just measured by the duration of the vibration, which we can calculate. We find the velocity like that of light. If the correctness of this calculation is doubted, we have another resource. The velocity of electric waves in metallic wires is enormous, and quite equal to their velocity in the air. Further than this, it was directly measured a considerable time ago; for the problem was easily studied on wires kilometres long. We therefore have a purely experimental valuation of this velocity, and, although the result is only approximate, it does not contradict the one we have just got.

These experiments are all very simple at the bottom, and yet they have most important consequences. They overthrow every theory that assumes that electrical forces traverse space instantaneously, and mark the triumph of Maxwell's system. It is no longer a simple thread of union between two orders of distinct phenomena. While his theory of light seemed at first to be probable, it is now hard not to regard it as true. But it may be that in approaching this end we shall be able to dispense with the support of the theory. Our experiments took place very near that neutral zone which, according to it, unites the domains of light and electricity. Only one step remains to be taken to land in this domain of optics, which is well known to us. It will not be superfluous. There are many friends of Nature interested in the problem of light who are capable of comprehending simple experiments, but to whom Maxwell's theory is still unintelligible. Moreover, the scientific method requires us to avoid roundabout ways when it is possible to follow a direct one. If, then, we succeed in producing phenomena like those of light by means of

electric waves, all theorizing becomes superfluous; the identity of the two orders springs from the experiments themselves. Success in this way also is possible. Let us place the conductor that produces the variation of the electric condition in the focus of a large concave mirror. The electric waves will join, and will come forth from the mirror in the form of a rectilinear beam. We can, it is true, neither see nor touch this beam; but we know it is there, because we can see sparks pass from it to the conductors which it meets; and it becomes sensible when we arm ourselves with our electrical resonator. Its properties are all those of a luminous ray. We can, by turning the mirror, send it into different directions. Studying the path which it follows, we may see that it is propagated in a straight line. If we interpose conducting bodies in its way, they will not let it pass; they cast a shadow, but do not destroy the ray; they reflect it, and we can follow the reflected beam and satisfy ourselves that it follows the laws of the reflection of light. We can also refract it as we do light; and, as we use a prism to study the refraction of light, so we do here. But the dimensions of the waves and of the beam force us to take a very voluminous prism. So we select a cheap substance—pitch or asphalt. Finally, we can study on our ray phenomena which we have heretofore observed only in light, those of polarization. If we place a kind of metallic grate in the track of the beam, we can observe our electric resonator emitting sparks or remaining quiescent in obedience to the same geometric laws as govern the variations in the glow of a ray of light in passing through a polarizing apparatus.

In making these experiments we have come into the domain of optics. In describing them we speak no longer of electricity, but use the language of optics. We do not say that the currents pass along the conductors, or that the electricities unite. We see nothing but undulations crossing one another in space, separating, combining, and re-enforcing or weakening one another. Having started from the domain of pure electricity, we have come step by step to purely optical phenomena. The passage is made for henceforth, and the road has become easy. The identification of light and electricity, which science suspected and theory predicted, has been definitely established, made perceptible to our senses and intelligible to the mind. From the heights we have attained, where the two orders of phenomena are blended, we look into the domains of optics and electricity. They seem more vast than we had supposed them to be. Optics is no longer limited to ethereal undulations of a few fractions of a millimetre, but includes waves the length of which is measured in decimetres, metres, and kilometres. But, enlarged as it is, it is still only an appendage to electricity. That gains yet more advan-

tage. We shall hereafter see electricity in a thousand conditions in which we did not before suspect it. Every blaze, every luminous atom becomes an electrical phenomenon. Even if a body does not cast light, it is a center of electrical action if it radiates heat. The domain of electricity is therefore extended over all nature, and even possesses us; for is not the eye, in fact, an electrical organ? Such are the results which we obtain in these questions of detail; those that concern the philosophy of science are no less important.

One of our most difficult problems is that of actions at a distance. Are they real? Of all those which seemed indisputable to us, gravitation is the only one that is left. Will it also escape? The laws of its action themselves provoke the thought. The nature of electricity is another of these great Unknowns. It reverts to the question of the condition of electrical and magnetic forces in space. Behind this rises the most important problem of all—that of the nature and properties of the substance that fills space, of the ether, its structure, its movements, and its limits—if it has any. We see this question becoming more and more dominant over all the others. The knowledge of the ether seems destined not only to reveal to us the condition of the imponderable substance, but also the nature of matter itself and its inherent properties—weight and inertia.

The ancient systems of physics summarized everything as formed of water and fire. Modern physics will shortly be asking if all existing things are not modalities of the ether. Here lies the ultimate end of our knowledge, the culmination of all that we can hope to learn. Shall we ever reach it? Soon? We do not know. But we have reached a greater height than ever before, and we have gained a solid point of support which will make our upward progress and search for new truths easier. The way that is opening before us is not too steep, and the next step does not look inaccessible. There is a numerous company of seekers full of ardor and knowledge; and we wait with confident hope all the attempts that will be made in that direction.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

A NEW method of disposing of the dead, which he calls "sanitary entombment," is proposed by the Rev. Charles R. Treat. It is intended to combine the feature of deposition in a tomb with desiccation, whereby the preservation is secured of the body freed from all noxious properties. An arrangement of buildings is contemplated, like that of the Campo Santo of Pisa, so constructed that anhydrous air may enter the tomb and pass over the body to absorb all moisture and morbific matter, which it will convey to a separate structure, where all shall be consumed in a furnace. Thus the form of the body may be retained, while all of it that is subject to decay is cremated.

DEFENSES OF BURROWING SPIDERS.*

By HENRY C. McCOOK, D. D.

THE simplest form of burrow is that of the *Tarantulas*, which represent the largest known spiders. These huge araneads appear to depend wholly upon their size to resist the assaults of enemies who invade their den. At least I have not found satisfactory evidence that they erect any artificial barrier over the entrance to their tunnels.

A more complicated burrow, and one better serving for defense, is that of *Leptopelma cavicula* of northern Africa. The drawing (Fig. 1) shows a section view of the upper part of the burrow, the entrance to which is without any door or other defense as in the case of the tarantulas. The burrow descends perpendicularly for a little way, but at the top a special branch diverges laterally, which curves and again descends perpendicularly for a considerable distance. At the summit of this second and parallel perpendicular tube another branch issues, inclining upward toward the surface. A glance at this structure, if we suppose it to be characteristic of the species, and not an accidental formation, will show that it makes an admirable protection against heavy rains, which sink away into the first burrow as a kind of reservoir, enabling the spider to escape by the diverging branch. Against enemies who pursue it into its den, this structure also presents an effectual defense, for, while an enemy naturally would rush downward into the first direct passage, the spider may escape by the lateral branch. Supposing that the enemy, observing the mistake, ascends and follows along the branches, the spider has the opportunity to push up into the second branch while the pursuer, again following its natural instinct, would rush down the second perpendicular tube. I am here in the region of conjecture, but perhaps no better explanation presents itself.

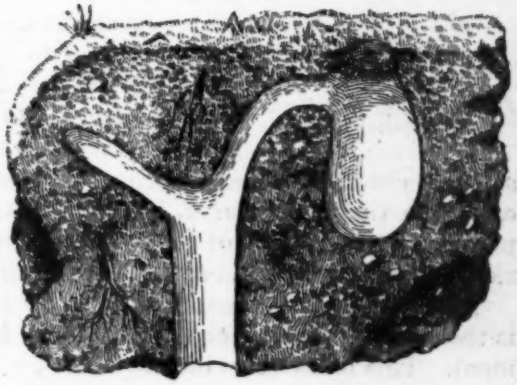

FIG. 1.—BURROW OF *Leptopelma cavicula*. Section view of upper part.

* Reprinted from Vol. II of American Spiders and their Spinning-work, by the kind permission of the author, to whom we are also indebted for the accompanying illustrations.

A third stage in the development of this defensive industry is represented at Fig. 2, which shows the external tube of *Leptopelma elongata*. This is simply a lily-shaped tube of pure white spinning-work, rising directly above the burrow, and supported by surrounding foliage. The purpose of this structure has not been positively determined. As able a naturalist as A. R. Wallace has conjectured that it may be deceptive in its uses, its resemblance to a flower attracting to it insects, which are thus preyed upon by the proprietor. Such elevated objects are certainly apt to attract insects, who are disposed to alight upon them without regard to their promise of providing food. But I am inclined to believe that Leptopelma's silken lily serves as a watch-tower from which she can observe the approach of enemies and make good her escape in time. Moreover, I believe that it is possible for her to pull together the sides of the sheeted turret and thus erect a barrier between herself and some of her feebler pursuers.

FIG. 2.—LILY-SHAPED TUBE OF *Leptopelma elongata*.

Another form of defensive industry is presented at Fig. 3, which is the exterior part of the turret tube of *Dolichoscaptus inops* (Simon). This is about an inch in height, and is composed of mingled chippage and mud, a sort of *débris* of chopped straw and soil.

FIG. 3.—TURRET OF *Dolichoscaptus inops*. (Natural size.)

A still further stage is shown at Fig. 4, which represents a columnar turret of *Dolichoscaptus latastei*, several inches high. This resembles the tower of the preceding species, but adds thereto a hinged covering after the manner of a trap-door. This turret is also composed of chippage and *débris* of various sorts gathered from the neighborhood, and is supported upon the surrounding foliage, which in the drawing is a plant of *Lavandula dentata*. All the uses to which such an elevated structure can be put are served by this ingenious structure, and, in addition, the trap-door is manifestly intended to defend the inmate from the assaults of enemies.

We come now to the trap-door nests of *Nemesia meridionalis*, and other species making traps of the wafer type, as so fully de-

scribed by Moggridge. Here we have simply a dropping away of the turret of *Dolichoscaptus*, and the use of the burrow independently of the same, but with the trap-door retained. In the species studied by Moggridge a single burrow is the ordinary rule; but there are many variations, some of which are manifestly characteristic of species, and others which are probably occasional and accidental.

FIG. 4.—TURRET, WITH TRAP-DOOR, OF *Dolichoscaptus latastei*, supported on a plant —four inches high. (After Simon.)

A variation described by Mr. Simon is shown at Fig. 5, the nest of *Stothis astuta*, which inhabits the forest of Cartuche, near Carácas, South America. The drawing shows a section of the burrow, indicating the curved course, and also the two wafer-like trap-doors habitually placed at either end. That this peculiar industry is defensive is probable, for we can readily imagine the spider disappearing within its den at one door, and, if its pursuer should succeed in entering the same, escaping at the other. We might, without much stress of imagination, carry the conception a little further, and suppose, again, the enemy making its exit from one door and the spider again descending into its burrow by the other. This game of bopeep might evidently be played to the great advantage of the trap-door spider, and manifest disconcerting of its enemy.

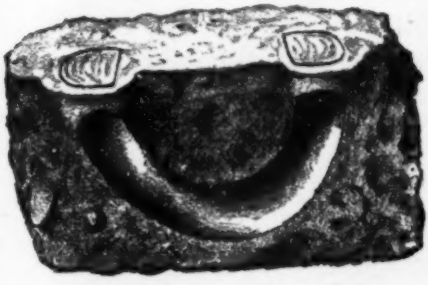

FIG. 5.—SECTION VIEW OF CURVED BURROW OF *Stothis astuta*, SHOWING DOUBLE TRAP-DOOR ENTRANCE.

Simon gives an interesting example of the ability of a spider of this species to change its habit and adapt its industry to unexpected surroundings. The species commonly seeks dark and damp localities, and digs in vegetable earth a burrow not very deep. The nest was begun underneath a stone in soil which was so rocky as to be impenetrable. Not wishing to change its site, and

not to be cheated out of its proposed domicile, Stothis proceeded to erect a cylindrical case about two inches long, composed of a conglomerate gathered from surrounding particles of soil and vegetable chippage. These were cunningly wrought together, the whole structure silk-lined, and the characteristic trap-doors hung, one at either end. Thus, while varying her habit in so far as to build a surface tunnel instead of a subterranean one, Stothis preserved her defensive habit of erecting for herself a back door by which she could retreat in case of invasion at the front door.

The burrow of *Stothis cenobita* (Simon) is simply a rounded chamber underneath the surface, and closed by a trap-door, which differs in no particular, as far as I can observe, from the ordinary trap-door of the American *Cteniza californica*.

It is difficult to say what may be the enemies of the trap-door spider against which such ingenious architecture has been reared and such vigilant watch is exercised. But the quite general testimony is that these spiders leave their tubes at night and go forth in search of prey; or, as in other cases, open the lids of their tunnels and spread straggling lines near by, upon which passing insects are entangled and delayed long enough to allow the spiders to pounce upon them from their open caves. If we credit these accounts, we might infer that the enemies which the trap-door spiders most dread are not such as are abroad at night. Evidently the creatures are fearless at that time—a state of mind which doubtless results from their knowledge that they are comparatively free from their worst enemies. The enemies which they most dread may therefore be reasonably looked for among diurnal creatures, and not among those of nocturnal habits. Among these foes, at least one of the most formidable and irresistible is a diurnal insect, the female of the terrible digger wasp, which I do not doubt will be found to store trap-door spiders, as well as tarantulas and lycosids. There is no evidence known to me that *Pepsis formosa* invades the tunnel of the *Mygalidæ* in order to dig them out. Such an act is not, indeed, beyond her powers; and, reasoning from the conduct of *Elis 4-notata*, it is highly probable. But we are not yet warranted in attributing the habit to her. Some lizard or mammal that might pull open the trap with its claws may be looked for as also a probable enemy against which trap-door spiders erect and defend their ingenious barrier.

At all events, the spider herself is well aware of these enemies. Abbé Sauvages invariably found, when he attempted to open the door of the nest of "the mason-spider" (*Nemesia* and *Cteniza*), that the mother was on guard, holding down the lid of her tunnel with great force. In his efforts to pull the trap-door up, the spider would jerk it down, and there would be an alternate opening and

shutting of the nest until his purpose was accomplished. It is the habit, according to Moggridge, Simon, and all observers who have noted the point at all, for these animals to hang back downward upon the inner surface of the door. In many nests which I have seen there are holes along the outer or free edge of the door—the part directly opposite the hinge—which mark the points at which, probably, the fangs of the spider had been fixed, in order to give it a strong purchase against intruders.

One of the most curious examples of relation of structure to enemies, or perhaps of the reaction of hostile environment and agents upon structure, is found in a territelarian spider (*Cyclocosmia truncata*). This aranead, according to Hentz, dwells like others of its kind in cylindrical cavities in the earth. Though many specimens were found, he never saw any lid or closure to the aperture of its dwelling. The very singular formation of its abdomen, which is as hard as leather behind, and is truncated to form a perfect circle, induced Hentz to believe that when in danger it closes its dwelling with that part of its body instead of with a trap-door or lid. This conjecture, of course, needs confirmation, though it seems not improbable; and one may imagine the intellectual confusion of a pursuing enemy which finds its prey suddenly disappearing within a hole in the ground, but which, when investigated, presents nothing but a level surface where certainly a hole ought to have been! The dorsal view of the spider is given at Fig. 6, the side view at Fig. 7; and a diagrammatic section view of the creature is drawn at Fig. 8, as it probably would appear when closing up the opening to its burrow.

Fig. 6.—*Cyclocosmia truncata.*

Fig. 7.—Side View of same. (After Hentz.)

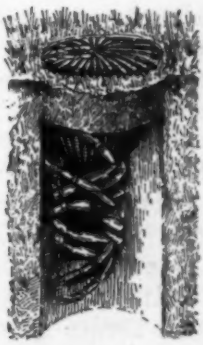

Fig. 8.—Diagrammatic View of Truncata, closing her Burrow with her Abdomen.

ARCHITECTURE AND THE ENVIRONMENT.

By BARR FERREE.

THE natural conditions that are essential for successful building have never been better set forth than in a letter written by the consul Pliny to his friend Gallus in the early part of the first century of our era, in which he describes his newly-finished villa of Laurentinum.

"You are surprised," he writes, "that I am so fond of my Laurentinum, or (if you like the appellation better) my Laurens; but you will cease to wonder when I acquaint you with the beauty of the villa, the advantages of its situation, and the extensive prospect of the sea-coast. It is but seventeen miles from Rome; so that, having finished my affairs in town, I can pass my evenings here, without breaking in upon the business of the day. There are two different roads to it: if you go by that of Laurentum, you must turn off at the fourteenth mile-stone; if by Ostia, at the eleventh. Both of them are, in some parts, sandy, which makes it somewhat heavy and tedious, if you travel in a carriage, but easy and pleasant to those who ride on horseback.

"The landscape on all sides is extremely diversified; the prospect in some places being confined by woods, in others extending over large and beautiful meadows, where numberless flocks of sheep and herds of cattle, which the severity of the winter has driven from the mountains, fatten in the vernal warmth of this rich pasturage. My villa is large enough to afford all desirable accommodations, without being extensive. The porch before it is plain, but not mean, through which you enter into a portico in the form of the letter D, which includes a small but agreeable area.

"This affords a very commodious retreat in bad weather, not only as it is inclosed with windows, but particularly as it is sheltered by an extraordinary projection of the roof. From the middle of this portico you pass into an inward court, extremely pleasant, and thence into a handsome hall, which runs out toward the sea; so that, when there is a southwest wind, it is gently washed with the waves which spend themselves at the foot of it.

"On every side of this hall there are either folding-doors or windows equally large, by which means you have a view from the front and the two sides, as it were, of three different seas; from the back part you see the middle court, the portico, and the area; and by another view, you look through the portico into the porch, whence the prospect is terminated by the woods and mountains which are seen at a distance. On the left hand of this hall, somewhat farther from the sea, lies a large draw-

ing-room; and beyond that a second of smaller size, which has one window to the rising and another to the setting sun; this has likewise a prospect of the sea, but, being at a greater distance, is less incommoded by it. The angle which the projection of the hall forms with this drawing-room, retains and increases the warmth of the sun; and hither my family retreat in winter to perform their exercises: it is sheltered from all winds except those which are generally attended with clouds, so that nothing can render this place useless, but what, at the same time, destroys the fair weather.

"Contiguous to this is a room forming the segment of a circle, the windows of which are so placed as to receive the sun the whole day; in the walls are contrived a sort of cases, which contain a collection of those authors whose works can never be read too often. Thence you pass into a bedchamber through a passage which, being boarded and suspended, as it were, over a stove which runs underneath, tempers the heat which it receives and conveys to all parts of this room. The remainder of this side of the house is appropriated to the use of my slaves and freedmen; but most of the apartments are neat enough to receive any of my friends.

"In the opposite wing is a room ornamented in very elegant taste: next to which lies another room, which, though large for a parlor, makes but a moderate dining-room; it is exceedingly well warmed and enlightened, not only by the direct rays of the sun, but by their reflection from the sea. Beyond is a bedchamber, together with its anteroom, the height of which renders it cool in summer; as its being sheltered on all sides from the winds makes it warm in winter. To this apartment another of the same sort is joined by one common wall. Thence you enter into the grand and spacious cooling-room belonging to the bath, from the opposite walls of which two round basins project, sufficiently large to swim in. Contiguous to this is the perfuming-room, then the sweating-room, and next to that the furnace which conveys the heat to the baths; adjoining, are two other little bathing-rooms, fitted up in an elegant rather than costly manner; annexed to this is a warm bath of extraordinary workmanship, wherein one may swim and have a prospect, at the same time, of the sea.

"Not far hence stands the tennis court, which lies open to the warmth of the afternoon sun. Thence you ascend a sort of turret, containing two entire apartments below; and there are the same number above, besides a dining-room which commands a very extensive prospect of the sea, together with the beautiful villas that stand interspersed upon the coast. At the other end is a second turret, in which is a room that receives the rising and the setting sun. Behind this is a large repository, near to

which is a gallery of curiosities, and underneath a spacious dining-room, where the roaring of the sea, even in a storm, is heard but faintly; it looks upon the garden and the *gestatio* which surrounds the garden. The *gestatio* is encompassed with a box-tree hedge, and, where that is decayed, with rosemary; for the box, in those parts which are sheltered by the buildings, preserves its verdure perfectly well; but where, by an open situation, it lies exposed to the spray of the sea, though at a great distance, it entirely withers.

"Between the garden and this *gestatio* runs a shady plantation of vines, the alley of which is so soft that you may walk barefoot upon it without any injury. The garden is chiefly planted with fig and mulberry trees, to which this soil is as favorable as it is averse to all others. In this place is a banqueting-room, which, though it stands remote from the sea, enjoys a prospect nothing inferior to that view: two apartments run around the back part of it, the windows whereof look upon the entrance of the villa, and into a very pleasant kitchen garden. Hence an inclosed portico extends, which by its great length you might suppose erected for the use of the public. It has a range of windows on each side, but on that which looks toward the sea they are double the number of those next the garden. When the weather is fair and serene, these are all thrown open; but if it blows, those on the side the wind sets are shut, while the others remain unclosed without any inconvenience.

"Before this portico lies a terrace, perfumed with violets, and warmed by the reflection of the sun from the portico, which, as it retains the rays, so it keeps off the northeast wind; and it is as warm on this side as it is cool on the opposite; in the same manner it proves a defense against the southwest; and thus, in short, by means of its several sides, breaks the force of the winds from whatsoever point they blow. These are some of its winter advantages: they are still more considerable in summer; for at that season it throws a shade upon the terrace during all the forenoon, as it defends the *gestatio*, and that part of the garden which lies contiguous to it, from the afternoon sun, and casts a greater or less shade, as the day either increases or decreases; but the portico itself is then coolest when the sun is most scorching—that is, when its rays fall directly upon the roof. To these, its benefits, I must not forget to add that, by setting open the windows, the western breezes have a free draught, and by that means the inclosed air is prevented from stagnating. On the upper end of the terrace and portico stands a detached building in the garden, which I call my favorite; and indeed it is particularly so, having erected it myself. It contains a very warm winter room, one side of which looks upon the terrace, the other has a view of the sea,

and both lie exposed to the sun. Through the folding-doors you see the opposite chamber, and from the window is a prospect of the inclosed portico.

"On that side next the sea, and opposite to the middle wall, stands a little elegant recess, which, by means of a glass door and a curtain, is either laid into the adjoining room, or separated from it. It contains a couch and two chairs. As you lie upon this couch, from the feet you have a prospect of the sea; if you look behind, you see the neighboring villas; and from the head you have a view of the woods; these three views may be seen either distinctly from so many different windows in the room, or blended together in one confused prospect. Adjoining this is a bedchamber, which neither the voice of the servants, the murmuring of the sea, nor even the roaring of a tempest can reach; not lightning, nor the day itself, can penetrate it, unless you open the windows. This profound tranquillity is occasioned by a passage which separates the wall of this chamber from that of the garden; and thus, by means of that intervening space, every noise is precluded. Annexed to this is a small stove-room, which, by opening a little window, warms the bedchamber to the degree of heat required. Beyond this lie a chamber and antechamber, which enjoy the sun, though obliquely indeed, from the time it rises till the afternoon. When I retire to this garden apartment, I fancy myself a hundred miles from my own house, and take particular pleasure in it at the feast of the Saturnalia, when, by the license of that season of festivity, every other part of my villa resounds with the mirth of my domestics; thus I neither interrupt their diversions nor they my studies."

This remarkable letter was written in a civilization different from ours, when society and culture were developed in another spirit; yet the principles it so clearly illustrates are as much in force to-day as they were then, and the lessons it teaches as important to us as they were interesting and profitable to the friend to whom they were addressed. It matters not that the description is of a building erected more than eighteen hundred years ago, which has long since passed from the face of the earth. The truths involved in its construction are as real to-day as when the letter was freshly written, and, great as is its archæological interest, its chief merit is the admirable way in which it describes the model dwelling. Pliny was not an architect, but he was a man of keen observation, a student of nature, and possessed of sound common sense, which he never exercised to better advantage than in the erection of this building. His description shows us that utility is the chief consideration, first, last, and all the time, that should be observed in constructing a house. Coupled with this are the conditions imposed by the environment, the taking

advantage of the natural situation, the direction of the wind, the heat of the sun, the requirements of temperature and climate, all of which must receive due attention in good and economic building. Ornamentation, decoration, design, æsthetic effects, and other elements which are popularly supposed to compose architecture, are either neglected altogether or put to one side as matters which may receive attention after essential things have been considered. The Romans were fond of ornament, they loved to overload their structures with decorations of all kinds, and the number of statues employed in some of their public buildings was prodigious; but Pliny's letter shows that there were at least some among them who looked at architecture through the lens of common sense, and it is to them we must go in our search after truth.

Adaptation to its use was the chief element in Pliny's villa, the basis on which it rested, and the plan on which it was designed. There was no insistence on the beautiful or the elevation of artistic form to the chief place, but everything was arranged as convenience dictated or sense suggested, and all was in consequence admirably suited to the requirements of the owner. It was in these things that he found satisfaction, while if any part was arranged with elegance, so much the better; but as long as he was comfortable, as long as his windows opened on refreshing views, as long as every advantage was taken of the shade in summer or the heat of the sun in winter, as long as there were convenient and accessible places of retreat as well as ample rooms in which to entertain the guests, there was no fault to be found, and, as the owner was satisfied, who could complain?

The pleasure that Pliny derived from his villa is in striking contrast to the dissatisfaction that is expressed with modern buildings of all kinds—not dwellings alone, but stores and offices, churches and public buildings; with those erected in an inexpensive way, and those on which unlimited sums have been expended. The fault-finding is not a subdued murmur, but is general and outspoken, and, in the absence of any other object, is aimed at the architect, sometimes with a vigor that should be sufficient to arrest his attention. And the architects are largely to blame; for, as the leaders in the architectural movement, they naturally have a fuller acquaintance with the subject than a man who builds but one house in a lifetime, and, if they do not correct errors in construction, it is difficult to see who else is to be held responsible. The reasons for this state of things are obvious. Every man who undertakes to build a house seeks to make it a model dwelling in which the faults of every other building he is acquainted with will be corrected, and everything arranged to suit his ideas of comfort and utility. He begins with well-defined views, knows exactly what he wants, and lays them before

the architect. The latter undertakes to please his client as best he may and prepares—a design. Possibly the plan is in accordance with the programme laid down, but it is by a picturesque exterior, a pleasing elevation, a beautiful drawing, that he hopes to captivate the eye and fancy of his customer. Other architects have made their reputation by their exteriors, and the most successful of all has obtained his fame by some great structure whose façade surpasses in beauty any offered by his competitors. Like a flock of sheep blindly following the leader, they go on preparing design after design, such as it is supposed the client will like, until an immense portfolio of pictures will be accumulated which may be very pleasing to look at, but which are simply drawings intended to catch the eye. The plan, the arrangement of the parts of the house, the convenience of the occupants, and all similar questions are too frequently left to be filled in afterward, and made to fit the exterior instead of the exterior being made to express them.

Architecture, in fact, has ceased to be an art, and has become a fashion. We have styles in architecture just as we have styles in dress, and the changes in public taste are as capricious in the one as in the other. The rule of fashion is the most arbitrary and idiotic form of government to which human beings have ever submitted themselves, and it is not less so in architecture than in dress. Our buildings are put up now in one style, now in another, not because one is more suited to the purpose of the structure, not because it is better adapted to the climate, not because it more freely expresses our culture and our civilization, but because we want a change—because our streets are growing monotonous, because we must alter our structures to conform to the new style, and thereby give evidence of an improved taste and furnish profitable work for the architect and good jobs for the laboring man. As to what is behind all this—the structure itself, the part which calls the façade into being, to which it is really not more than a lid or screen to shut out inquisitive eyes—it does not matter. An Italian front does not necessarily imply an Italian house, nor a Moorish façade suggest the rich, luxurious, sensual life of the south. Variety is indeed the spice of life, and it is an admirable idea to give a diversity to our streets and erect ornamental façades to our buildings; but when we pass over all thought of convenience, of utility, of adaptation to natural conditions, and judge of buildings solely because one is better looking than another, we have passed the dividing line between sense and absurdity.

From the modern point of view it is a misfortune that buildings must be used. Were they only intended to be looked at, could they but be preserved in glass cases in the galleries of some

gigantic museum, there would be no complaints, no fault-findings, no grumblings. If houses were not to live in, architects could pursue their occupations without inconvenience, and design fronts and windows and turrets and all sorts of knickknacks to their hearts' content. Unfortunately, this ideal state can never be realized; and, as people must conform to the designs of architects—must have turrets where they do not want them, windows where they are least needed, and all sorts of beautifications because they are in the latest style—there is constant conflict between builder and occupant, between architect and client. Nor could anything else be expected when buildings are judged solely by their æsthetic appearance. The history of architecture carries the comforting assurance that structures can be both beautiful and useful; and, in fact, in the best buildings the two elements are so closely united as to be scarcely distinguished. In our time, however, attention is paid to only one of them, and it is, therefore, impossible to obtain satisfactory results.

Writers on architecture make a broad distinction between construction and architecture, claiming that they are two different things, and that, while all architecture is construction, all construction is not architecture. Never was a difference productive of more perverted ideas. A factory is not architectural, because it is plain, unadorned construction. Put on some ornament, add a fancy roof, a cornice, and a balcony, and it at once becomes architectural, though none of these things have aught to do with the uses of the building, but frequently conflict with them. Such a definition may be maintained in order to have certain limitations, but it is clearly absurd to say that a building only properly comes within the province of architecture when certain adjuncts are added to it which, while they may increase its æsthetic appearance, detract from its usefulness.

The history of architecture is the story of the attempt of man to adapt his life to the environment in which he is placed. The Abipone under his mat, the Assyrian in his thick-walled house of brick, the Roman in his conveniently arranged villa, the mediæval baron in his castle, the French monarch in his richly appointed palace, are but so many instances of the influence of climate and geological conditions, nature of the soil, products of the land, extent of intercourse with other peoples, temperature, rainfall, manner of living, and many other phenomena which have caused the evolution of various grades of society, and which thus express themselves in visible form. In Assyria the buildings were of clay, because that was the only substance the land afforded. In Greece they were of stone, because it was abundant and easily obtained. The mediæval baron intrenched himself in a heavily guarded fortress, because the country was

in an unsettled condition and was infested with freebooters. A change passed over society; laws were enforced, police regulations made, society became settled and calm, fortifications disappeared, and in their place arose châteaux and pleasant villas that were admirably suited to a free and peaceful life. Each style, in fact, originated in the various operations of natural conditions; each form had an evolution of its own, that had as definite and as readily ascertained causes as those which produced the evolution of any other form of culture. Reason and common sense, usefulness and intention, were the great factors on which all architecture rested; and when these things were neglected—when an arbitrary decree of fashion or the development of a new "taste" became the criterion by which all buildings were judged—architecture fell. This calamity occurred with the introduction of the Renaissance in the fifteenth century, and its results are still apparent.

Natural conditions are apt to be forgotten in this busy life of ours. We have no time to spend in applying the problems of perspective to architecture as did the ancient Greeks when they used curved lines instead of straight, in order to correct the distortion caused by distance. Our crowded cities, where land has reached fabulous prices per foot, afford no opportunity for taking advantage of the conveniences of an ample site. But, though we may not be able to concern ourselves with such matters, there are a multitude of other details that can be attended to which are now more or less neglected, and which, were they intelligently treated, would remove much of the present reproach from our architecture.

For many hundred years architecture has been occupied with solving problems presented by Nature. In earlier times life was comparatively simple, and artificial needs were few and easily satisfied. Now, however, we have countless mechanical contrivances that have entered closely into our lives, and the problems of architecture take a different range. Steam and electricity have revolutionized society. They have brought the furthermost parts of the earth into intimate connection. Our lives are one continuous hurry, and the laggard is soon left behind in the rapid march of progress. In the cities land is scarce and valuable, and room is only to be had by expanding upward instead of laterally. Inventive genius has supplied us with elevators, steam heat, electric light. Questions of public safety, correct sanitation, guards against fire, protection against burglary, safe means of rapid ingress and egress, have formed other conditions. The spread of manufactures, the making of artificial building materials, as iron and glass, have given us new forces. New methods of business and the constant and rapid introduction of new occu-

pations have presented fresh problems with which to deal. The increase of great corporations, the building of railroads, new forms of transportation by water, the changes of life in every state, have caused new difficulties for the architect, all of which must be correctly solved if we are to make any true progress.

In our houses, stores, office-buildings, hotels, homes, factories, machine-shops, depots of construction, warehouses, churches, dwellings, and places of amusement, there is a constant need for the application of new ideas and the devising of new methods. The work that is before our architects is immense, and the way in which they apply themselves to it will largely influence our future advancement. Yet in the face of all this the battle of the styles waxes furious; and if one obtains a handsomer building than his neighbor, he is told not to complain of its inconveniences, but to be satisfied that he has got so much. There never was a time when the need of a practical architecture was more pressing than now, and there never was a time when it was so persistently neglected.

And what is a practical architecture? Is it one in which beauty is sacrificed to utility, where plainness is to be preferred to ornament, where art is subordinated to engineering? Not at all; we can have beauty and utility, art and engineering, all in one building, and still be practical and in line with good architectural work. It is true that many "practical" buildings are extremely ugly, and many great works of engineering eminently hideous. It is small wonder at times that there is a revulsion against the practical and a demand for more of the beautiful; but the error here is as great as when beauty is sacrificed to utility. Use is by no means synonymous with ugliness, and it is quite as important to combat such a view as to condemn beautiful things because they are useless. Practical architecture does not imply any compromise between the two elements, but it does imply a strict application of common sense to all material things. There is no reason why architecture should be denied the treatment from the point of view of sound sense that is given to every other department of thought and progress; it is too closely connected with the necessities of life to be made the victim of absurdity.

There is scarcely a limit to the number of examples of the neglect of natural conditions that may be gathered from the architecture that prevails among us. In the search for the beautiful, the demand for impressive façades, the taste for complicated ornament, and a most singular appreciation of the odd, the grotesque, and the ugly, there is little attention paid to matters which seem self-evident and are of really vital importance. Windows are arranged to suit a symmetrical façade, whether they are just what are needed for the rooms or not, and, even

where it is possible, little attention is given to the direction of the sunlight in order that the living-rooms may receive the full benefit of the natural warmth, nor are those rooms where it is not needed, or minor offices, relegated to the exposed side. The most important external feature, the door, is seldom adjusted to the climate. Even in large office-buildings, hotels, and churches, where there should be ample space for every structural convenience, the door is frequently of cramped dimensions, and, instead of being preceded by a porch, which would be an integral part of the architecture, and which is absolutely essential in our long, cold, damp winters, is boarded up with "storm-doors" that are not only hideous in design but an actual obstruction. With the rapid increase in the value of land which has taken place in all our large cities in late years, a wild fear lest any inch be wasted has resulted in a compactness of plan that is frequently painful. The housekeeper longs for the roomy closets and ample store-rooms of the old buildings; the fine hall that once formed an imposing and appropriate entrance has given place to the narrow entry through which it is frequently impossible to carry the larger articles of furniture. The same difficulty is experienced in the sharp, frequent turns which characterize so many stairways. Bedrooms are pushed into corners where they seldom have the benefit of pure, free air and the heat of the sun, for no other reason than that space is required for ample reception-rooms and state apartments, which, though used comparatively seldom, are treated as the most important part of the house.

The same indifference to the true ends of building are to be noted in public edifices as well as in private ones. Offices are small and frequently without light. In many churches it is impossible either to see the preacher or to hear him, and some of our public halls are not much better, while, as a crowning touch, the seats are placed so close together as to render them the very acme of discomfort to all but dwarfs. Nor are these structural differences the only ones that call for improvement. There are a multitude of modern contrivances that are yet in an undeveloped state. Questions of drainage, of heating, of artificial light, of elevators, of protection against fire, of ventilation, and the very means of supporting life, are not seldom denied us in structures that astound us by their size and which have cost vast sums. It is not because these things are expensive that they are neglected, nor because they are out of the range of our mechanical powers, but because they are looked upon as adjuncts to the buildings to be taken up at some later time and are then never given the strict attention they require. A draughtsman who has prepared a design that captivates him by its beauty, and seems destined to win a much-desired prize by its mere art superiority over other draw-

ings, is too apt to forget that, after all, he has neglected the consideration of utility; and that on the perfection of the adaptation of the structure to human needs must depend its real value, its true measure of success.

The Great Pyramid of Egypt, which is among the most ancient monuments in the world, has survived for thousands of years because each stone had a definite place, in which it was set with the greatest care. It owes its size and its endurance to a strict attention, on the part of its builders, to small things, and the exercise of an almost limitless patience. It teaches a profound truth, that in architecture no single thing is too unimportant to be treated in the best way; and, though we need not seek to erect buildings whose permanency will be of the type of the Pyramid of Cheops, we can at least apply to our structures the same care for the minor parts, believing that, as the members are, so will the whole be.

Architecture must express the life of any people in order to be successful. It is this which makes former styles so admirable, and it is this element that is so sadly wanting in our own. We must not make our lives conform to our buildings, but our buildings must conform to our lives. They must express not only our culture and our tastes, but the land in which we live and the environment in which we are placed. This can never be accomplished by erecting buildings for their exterior only, and until our architects learn to treat the plan and disposition of the building as the chief part of the structure we can never hope to be rid of the discomfort that makes so much of our daily life unbearable. The Gothic builders achieved success, not because their buildings were beautiful only, but because they filled every natural requirement. It is impossible to delude ourselves with the thought that we are equally successful simply because we happen to live in a house with a Gothic front, but which subjects us to hourly annoyances by the total absence of the conveniences and necessaries of modern daily life.

BOTANY, said Prof. Marshall Ward, in the British Association, ought to be taught in schools because of the interest which the subject arouses in the mind of a child and the ease with which it can be taught. The study cultivates and stimulates those powers of accurate observation and comparison and conscientious recording of results so much needed by all, and which come naturally to children who are not too much under the bane of a mere instruction system. The value of such teaching is not to be measured by the number and kind of facts remembered, any more than historical knowledge consists of being able to remember the dates of battles and other events. The elements of botany afford to the teacher the cheapest, the cleanest, and the most convenient means of cultivating in young children the power of observation and comparison direct with nature, and afterward teaching them to generalize.

WHAT IS INDIVIDUALISM?

By M. HANDFIELD-JONES, M. D.*

SCIENTIFICALLY considered, individualism is the higher evolution of the atom or unit; viewed from a social standpoint, it is a process of intellectual development by which a man is marked out from his fellows. Individualism implies concentration of thought, tenacity of purpose, and a strong sense of self-reliance. It is the religion of the strong man, the master principle of his whole existence. Of this an old writer says: "As every machine has its mainspring, every animal body its heart, and the whole natural universe its sun, so, amid all the multiplied and intricate movements of our individual and social life, there must be one *master principle*—one all-regulating, all-impelling spring of action. If *this* be wrong, then, however fair and promising to ignorant observers, *all* is wrong. Human life should resemble a well-constructed drama. There may be variety, there may be episodes, but unity of action is indispensable, and all that is not in keeping, so as to swell the interest of the grand catastrophe, should be struck out as incompatible with all sound and wholesome criticism." If we seek a perfect exponent of this grand principle, we find it in the person of the Christus—that divine and human figure which men in all ages and in every clime have loved to contemplate. In him every power and every thought were developed and concentrated on one aim; he clung to the set purpose of his life with a tenacity which has never been rivaled; strong and reliant, he held the truth of his own teachings in the teeth of an opposing world.

The great enemy to individualism is laziness, and those who know anything of human frailties will, I am sure, bear me out when I say that "mental" laziness is far more common and far more difficult to overcome than that of the body. It is so much easier to accept dogmatic teaching, and to shift the responsibility of our views on to others, rather than to concentrate our thoughts and work out the lessons of our own observations; it is much more pleasant to butterfly from theory to theory than to seek truth with patient tenacity: why trouble ourselves to learn self-reliance, when natural indolence protests against the sacrifice? It is easier to imitate than to originate; plagiarism and mimicry are such prominent features in our lives, that their presence might almost be quoted as an argument in favor of our evolution in past ages from simian ancestry. How plausible are the ex-

* From an address On Individualism in its Relation to Medicine, delivered at St. Mary's Hospital Medical School, London, October 1, 1890.

cuses we make for our want of this individualism! We are so dreadfully afraid of being thought bumptious, we are so delightfully humble, we really do not wish to intrude our opinion, and yet all the brightest lights of our profession have been men of strong individualism. Harvey thought for himself, planned by patient investigation his theory of the circulation of the blood, and then, in the face of an opposition which cost him for a time his position, his reputation, and even his practice, dared to assert and stand by those views which we hold now as the fundamental principles of our art. Sir Joseph Lister stood very much alone, when, after deep research and careful experiment, he first promulgated his theory of antiseptic operating and paved the way for fresh and undreamed-of triumphs in the domains of abdominal and cerebral surgery. Ovariotomy had such a fearful death-rate at one time that its performance was held to be almost criminal; yet Sir Spencer Wells came forward, almost unsupported, and taught us that the operation was not only justifiable, but capable of being made the most successful of all the triumphs of surgical skill.

Names such as those I have just referred to may perhaps suggest the thought that individualism is another name for genius. The descriptions of genius have been many; thus Dr. Maudsley says, in his work on the Physiology of the Mind: "He who has what is called *genius* is in harmony with and assimilates the best thought of his own epoch and of preceding epochs, and carries it forward to a higher evolution. An age which lacks that impulse of evolution which the genius embodies is apt to harden in obstructive formula." For myself, however, I will define genius as the highest product of individualism, and I will add that, while few human beings reach genius, no human unit is without his share of individualism. Moreover, the more I study the life of a so-called genius such as Hunter or Newton, Faraday or Darwin, the more I am struck with the enormous amount of work which they contrived to compress into one short life. Longfellow probably had the same thought in his mind when he wrote:

> The heights by great men reached and kept
> Were not attained by sudden flight,
> But they, while their companions slept,
> Were toiling upward in the night.

I have stated that no human unit is without his share of the quality which we are considering; it needs only that he should be true to himself, and develop it. I have supported my argument by examples drawn from the highly educated classes, but I can with equal truth quote men engaged in what are termed the humbler walks of life. It is well known that for many of the great improvements in modern machinery we are indebted to working mechanics, men who, with no advantage save the educa-

tion of experience, have worked out their individual conceptions and revolutionized the course of an industry. I may be allowed to quote one interesting example. In the days of the old Enfield rifle, a large manufacturing firm in Birmingham used to make the barrels of these rifles for the Government. The process was in the main a simple one, the only difficulty being in securing that the barrel should be absolutely straight and true. To secure this latter point often occupied some time, but it was known that one particular workman had some secret of his own, by which he was enabled to glance down the barrel and say at once whether it was perfectly true or not. The man was often pressed to reveal his secret, but always declined. At last, one day for a drink and some two hundred pounds he sold the mystery. It seems he had noticed the simple fact that, when the tube was absolutely straight, no shadow was formed on looking down it toward the light, but if the slightest deflection existed a shadow was thrown on one or other wall of the barrel. Our argument, then, so far as we have followed it out, has brought us to three principal conclusions. firstly, that every man, whatever his station in life, is endowed with a personal equation of thought; secondly, that he can either simply store the raw material of facts and ideas as they are presented to him by others, or he can digest them and reproduce them stamped with the seal of his own individuality; thirdly, that it rests with ourselves either to be mere echoes of knowledge, or else "living voices" recording our own gleanings of truth for the help of coming generations.

Let us now apply these thoughts to the special region of medical education. In his Moral Philosophy, Prof. Stewart puts down *reverence for great names* as one of the principal hindrances to the spread of real knowledge; I wish he had written "to the acquirement of real knowledge," for I am firmly persuaded that no student has reached the first stage of progress until he has subordinated reverence for great names to a profound respect for his own individual opinion. Pray do not misunderstand me: I am not advocating disrespect for our teachers, but I would rather a student formed an erroneous diagnosis and stuck to it, provided always he could give me his reasons for having formed such a judgment, than that he should accept my dictum as a teacher without challenging me for the grounds on which I ventured to differ from him. A man has made a tremendous stride when he has learned to have the courage of his own convictions.

THE directors of the Montsouris Observatory, Paris, have found that the electrical disturbances produced by the passage of railway trains are a factor that has to be taken account of in the record of their observations. Two railroads pass close to the observatory, the trains of each of which produce peculiar and somewhat different effects.

THE "POROROCA," OR BORE, OF THE AMAZON.

By JOHN C. BRANNER,
STATE GEOLOGIST OF ARKANSAS.

I ONCE had an opportunity, while traveling upon the Amazon, to observe some of the effects of a remarkable phenomenon which occurs at the northern mouth of that river in connection with the spring tides. It is known to the Indians and Brazilians as the *pororóca*,* and is, I believe, generally supposed to be caused in the same manner as the "bore" of the Hoogly branch of the Ganges, of the Brahmapootra, and of the Indus.† I regret very much that, like Condamine, who passed through this region in 1740, I could not observe this phenomenon in actual operation; but the gentleman whose guest I was at the time, and upon whose boat I was a passenger, was fairly horrified at my suggesting such a thing, while his boatmen united in a fervent "God forbid that we should ever see the *pororóca!*" and ever afterward doubted my sanity. I give some of the results of my observations, however, as collateral evidence, and in order that those who in the future visit this particular part of the Amazon Valley, concerning which so little is known, may be able to see and establish as far as possible the rate of destruction and building up here being carried on.

I was upon a trip from Macapá—a small town on the northern bank of the Amazon, and about one hundred miles from its mouth—down the river to the ocean, and thence up the Rio Araguarý as far as the last might be navigable. The one inhabited place on the Araguarý is a very small military colony, called the Colonia Militar Pedro Segundo. At Macapá I became acquainted with the then director of this colony, Lieutenant Pedro Alexandrino Tavares, and was invited by him to visit the Araguarý.

The trip from Macapá was by a small sail-boat down the Amazon to the ocean, and thence up the Araguarý. Our departure was so timed that we should reach that part of the region disturbed by the *pororóca* exactly at the time of the month when there would be the least probability of its being met with—that is, at the time of the neap tides. The voyage down the river was in the face of the wind, and it was only five days after leaving

* Pronounced *paw-raw-raw'ca*. This word, which is of Tupý or native Brazilian origin, is the one invariably used by the Brazilians. Father João Tavares says it is probably a frequentative form derived from the Tupý word *opoe*, which means "to break with a noise."

† Similar phenomena, though on a much smaller scale, occur on the Garonne in France, on the Wye, Severn, and Trent in England, and on the following streams in Brazil: Rio Guamá, Capim, and Mojú in the province of Pará, on the Rio Purús in the province of the Amazonas, and on the Mearim in the province of Maranhão.

Macapá that we put into a channel on the island of Porquinhos to wait for the turning of the tide. I had already seen islands said to have been half washed away, and others built up, by the *pororóca;* and I had seen upon the shores the evidences of its destructive power in carrying away forests and cutting away banks; but it was on this island that I was first able to see some of its effects near at hand and at my leisure. After having seen so much, I was only the more anxious to see the *pororóca* itself; but my suggestions in regard to it were answered by an ominous silence on the part of the director, and my requests by additional expressions of horror.

As I shortly afterward met and conversed with a man who had seen the *pororóca*, I can not do better than give his description of it. This man was a soldier in the Brazilian army, and, on the occasion referred to, was going with a few other soldiers from the colony to Macapá in a small open boat. Arriving at the mouth of the Araguarý, they went down with the tide, and anchored just inside the bar which crosses the mouth of this stream, to await the turning of the tide, which would enable them to pass the shallows, and then carry them up the Amazon. Shortly after the tide had stopped running out, they saw something coming toward them from the ocean in a long white line, which grew bigger and whiter as it approached. Then there was a sound like the rumbling of distant thunder, which grew louder and louder as the white line came nearer, until it seemed as if the whole ocean had risen up and was coming, charging and thundering down upon them, boiling over the edge of this pile of water like an endless cataract, from four to seven metres high, that spread out across the whole eastern horizon. This was the *pororóca!* When they saw it coming, the crew became utterly demoralized, and fell to weeping and praying in the bottom of the boat, expecting that it would certainly be dashed to pieces, and they themselves drowned. The pilot, however, had the presence of mind to heave anchor before the wall of waters struck them; and, when it did strike, they were first pitched violently forward, and then lifted, and left rolling and tossing like a cork on the foaming sea it left behind, the boat nearly filled with water. But their trouble was not yet ended; for, before they had emptied the boat, two other such seas came down on them at short intervals, tossing them in the same manner, and finally leaving them within a stone's-throw of the river-bank, where another such wave would have dashed them upon the shore. They had been anchored, before the waves struck them, near the middle of the stream, which at this place is several miles wide.

But no description of this disturbance of the water can impress one so vividly as the signs of devastation seen upon the

land. The silent story of the uprooted trees that lie matted and tangled and twisted together upon the shore, sometimes half buried in the sand, as if they were nothing more than so many strings or bits of paper, is deeply impressive. Forests so dense that I do not know how to convey an adequate idea of their density and gloom, are uprooted, torn, and swept away like chaff; and, after the full force of the waves is broken, they sweep on inland, leaving the *débris* with which they were loaded heaped and strewn through the forests, or lodged in the very tree-tops. The most powerful roots of the largest trees can not withstand the *pororóca*, for the ground itself is torn up to great depths in many places, and carried away by the flood to make bars, add to old islands, or build up new ones. Before seeing these evidences of its devastation, I had heard what I considered very extravagant stories of the destructive power of the *pororóca;* but, after seeing them, doubt was no longer possible. The lower or northern ends of the islands of Bailique and Porquinhos seemed to feel the force of the waves at the time of my visit more than any of the other islands on the southeast side of the river, while on the northern side the forest was wrecked and the banks washed out far above Ilha Nova.

The explanation of this phenomenon, as given by Condamine, appears to be the correct one—that is, that it is due to the incoming tide meeting resistance in the form of immense sand-bars in some places and narrow channels in others. So long as the tide advances through a deep ocean, it moves freely and swiftly; but when it passes suddenly from the deep waters of the open ocean to the near-shore shallows, it stumbles upon them, as it were, and the waters are heaped up.*

Most persons who mention the *pororóca* say that it breaks as far up the Amazon as Macapá; and, indeed, the people of Macapá themselves often refer to the rapid cutting away of the river-banks near their city as the work of the *pororóca*. It is true that these banks are being rapidly cut down; and it is even a common thing to see, in this part of the country, the stilted houses—the floors being nearly two metres from the ground—that were originally built one, two, or three hundred feet from the water, gradually encroached upon until they fall into the stream. A portion of the old fort at Macapá was, at the time of my visit, about to fall, on account of the land upon which it was built being washed

* Prof. Hartt attributes the *pororóca* of the Rio Mearim in Maranhão to the form of the channel. It can not be questioned that the form of the channel may modify, and does modify, the force with which the surf strikes the shore; but the single fact of its great violence along the shores between the Araguarý and Cape North, where the whole coast is exposed to the open sea save for the protection offered by shallows, is sufficient to show that form of channel is not its sole cause.

away; but all this is the work of a rapid current, for the surf of the *pororóca* does not reach Macapá. Moreover, there is a marked difference in character between the washing done by the *pororóca* and that done by the ordinary river or tide current. The latter works from below, and, by undermining and softening the bank, causes what is known through the Amazon Valley as *terras cahidas*, or fallen banks. The land falls into the stream in sections of various widths, and not infrequently these form temporary terraces miles in length. These *terras cahidas* are most common and most extensive on the upper Amazon during high water; but they may be seen on a small scale at various places through the valley.* From this it is clear that the work of destruction goes on entirely below the surface. With the *pororóca*, on the contrary, the water is dashed fairly against the banks, the earth is washed away from above as well as from below, and the shore is left clear of loose *débris*. The depth to which the banks are cut shows that this disturbance is also a profound one; so much so, indeed, that on the northwest side of Porquinhos the deepest place in the channel of the river was, in 1881, close to this island, where the action of the *pororóca* was most violent.

Throughout this region of the Araguarý the *pororóca* is largely instrumental in the rapid and marked changes that are constantly going on. The water of the Amazon is notoriously muddy, and, as would naturally be expected, these disturbances in comparatively shallow places make it much more so, and fill it with all the sediment it can possibly carry. Even when I entered the Araguarý, a time when there was the least possible tidal disturbance, the water near the mouth of this stream was so muddy that a thick sediment would settle in the bottom of a vessel of it left standing a single minute; though the water of the Araguarý proper, as far down as the Veados, is of a clear, dark color. But the work of tearing down and that of building up is equally rapid, and the vegetable world takes quick possession of what the sea offers it; and, while some islands are being torn away, others are being built up, old channels being filled, islands joined to the mainland, and promontories built out. To the northwest of Faustinho is an island known as the Ilha Nova (New Island), about ten miles long by about three wide, when I saw it, and which, I was assured by several trustworthy persons, did not exist six years before. In 1881 it was covered by a dense forest. The young plants were sprouting at the water's edge, those behind were a little taller, and so on; so that the vegetation sloped upward and backward to a forest from twenty to thirty metres high in the

* For a good description of the *terras cahidas*, see The Naturalist on the Amazon, by Bates, fifth edition, p. 249.

middle of the island.* On the southern side of the mouth of the Araguarý was a point of land nearly or quite six miles in length, and covered with vegetation, from young shoots to bushes six metres high. I was told that one year before this was nothing more than a sand-bar, without a sign of vegetation on it. The western end of the island of Porquinhos was once known as Ilha Franco; but the channel that separated it from the Porquinhos has been filled up gradually, and the two islands are now one, though the upper end of it is still known as Franco. The point in the mouth of the Araguarý known as the Ilha dos Veados (Deer Island) was, at the time of my visit, fast being joined to the mainland. A couple of years before, boats navigating the Araguary passed through the channel on the south side of the island. In 1881 it was no longer navigable, and the Veados was rapidly being made part of the right bank of the river.

Owing to this shifting of material the pilots never know where to find the entrance to the Araguarý River. One week the channel may be two fathoms deep on the north side, and the next it may be in the middle; or it may have disappeared altogether, leaving the river-bed perfectly flat, with only one fathom of water across the whole mouth. The bar was in this last-mentioned condition when I passed over it in 1881. At this time another bar extended eastward from the eastern end of Bailique, while a little farther out was another just south of the same line. The shifting nature of the sand-bars about the mouth of the Araguarý renders it unsafe for vessels drawing more than one fathom to enter this river, except at high tides; but, as high tides and the *pororóca* come at the same time, only light-draught steamers can enter by waiting well outside the bar until the force of the *pororóca* is spent.†

With the few canoes or small sailing vessels that enter this stream (probably less than half a dozen a year) it is the custom to come down past Bailique with the outgoing tide, and to anchor north of the bar that projects from the southern side of the Araguarý, and there to await the turn of the tide to ascend the latter river. Care is always taken to pass this point when the tides are least perceptible.

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* The plants growing upon this newly formed land are all of one kind. They are called *Ciriúba*, or *Xiriúba*, by the inhabitants, and belong to the family *Verbenaceæ*, genus *Avicennia*.

† Probably the only steamers that have entered the Araguarý have been Brazilian men-of-war of light draught. But in 1881 there was nothing to take a steamer, however small, into this region; for, although the forests below the falls contain an abundance of rubber trees, and although cacao trees form extensive forests, there was at that time next to no population on the stream, while the malaria and the mosquitoes made it almost impossible to live there—indeed, this region is noted for being the most unhealthful on the lower Amazon. Some rubber is gathered above the falls, but it is carried overland from Porto Grande to the Rio Matapý and thence by canoes to Macapá.

Although the *pororóca* breaks as far up the Araguarý as midway between the Veados and the entrance to the Apureminho, its violence seems to be checked by the narrowing of the stream below the Veados, by the turns in the river, and by the vegetation along the banks.

This vegetation is of a kind against which it seems to be least effective—namely, bamboos. They grow next the stream from near the mouth to the foot of the falls above the colony, and for much of the distance form a fringe to the heavy, majestic forest behind them, than which nothing could be more strikingly beautiful. The clusters next the stream droop over till their graceful plumes touch the surface of the water, and, as the plants grow older, they droop lower, until the stream is filled with a yielding mesh of canes. I measured a number of these bamboos, and the longer ones, taken at random, were from twenty to twenty-five metres in length and from seven to ten centimetres in diameter. A more effectual protection against the *pororóca* could hardly be devised.

On Bailique and Brigue I found the forests very different from any I had hitherto seen in the tropics. These islands, like all the others in this part of the country, are flooded at high tide during part of the year, and, as a consequence, they are very like great banks of mud covered with the rankest kind of vegetation. This vegetation varies with the locality. All around the borders the island of Brigue is fringed with tall assai palms, bamboos, and various kinds of tall trees, all of which are hung with a dense drapery of *sipós* (lianes) and vines, which form an almost impenetrable covering. Inside of these are several palms, the most common being the *ubussú* (*Manicaria saccifera*). The next in order are the *murumurú* (*Astrocaryum murumuru*), *urucurý* (*Attelea excelsa*, the nut of which is used for smoking rubber), and *ubim* (*Geonoma*). But, unlike most tropical forests, this one has very little or no undergrowth, except upon the borders. Most of the ground was under from one to six inches of water, while the exposed places were covered with fine sediment deposited by the standing muddy waters of the Amazon. I walked several miles through this forest without finding any palms except the ones mentioned. The little ground above water was covered with the tracks of deer, pacas, cutias, and of many kinds of birds, mostly waders; but the death-like stillness was unbroken, save for the little crabs that climbed vacantly about the fallen palm leaves or fished idly in the mud for a living.

This half-land and half-water condition of the country is common not only in the immediate vicinity of the mouth of the river, but through a very large part of the valley of the Amazon, and is one of the most impressive features of this wonderful region.

But, instead of adding to what has already been written upon this subject, I will quote a few words from two writers, whose descriptions are entirely trustworthy: "All that we hear or read of the extent of the Amazons and its tributaries fails to give an idea of its immensity as a whole. One must float for months upon its surface in order to understand how fully water has the mastery over land along its borders. Its watery labyrinth is rather a fresh-water ocean, cut up and divided by land, than a network of rivers. Indeed, this whole valley is an aquatic, not a terrestrial basin." *

"This belt . . . can not be called either land or sea, island or archipelago. It is a veritable labyrinth of streams, canals, gulfs, islands, and lakes, combined in such a fashion as to impress one as to the caprice of man rather than as the work of Nature." †

This vast expanse of muddy water, bearing out into the ocean immense quantities of sediment; the *pororóca*, breaking so violently on the shores, and carrying away the coarser material to the open sea, and burying uprooted forests beneath newly formed land; the rank vegetation of islands and *varzea* rapidly growing and as rapidly decaying in this most humid of climates; the whole country submerged for a considerable part of the year by the floods of the Amazon—impress one with the probability of such phenomena having been in past ages, and still being, geological agents worthy of study and consideration. Across the mouth of the Amazon, a distance of two hundred miles, and for four hundred miles out at sea, and swept northward by ocean-currents, beds of sandstone and shale are being rapidly deposited from material some of which is transported all the way from the Andes, while in many places dense tropical forests are being slowly buried beneath the fine sediment thrown down by the muddy waters of the great river.

So many random and erroneous statements concerning the *pororóca* have been made by writers upon Brazil that I take this occasion to refer to and correct some of the most glaring of them.

Prof. William H. Edwards, who visited the Amazon region in 1846, has made way with it altogether, and says that "no one knows of such terrible phenomena nowadays," although he "inquired of several persons accustomed to piloting in the main channel, and of others long resident in the city of Pará." But, with the exception of a very few who have business relations in that direction, the people of the city of Pará, as a rule, know as little of the northern mouth of the Amazon as they do of the

* A Journey in Brazil, by Prof. and Mrs. Louis Agassiz, p. 256.

† Major João Martins da Silva Coutinho, in the Bulletin de la Société de Géographie, October, 1867, p. 330.

mouth of the Nile. And no wonder; for the Araguarý region can not be considered an attractive one in any respect, while the relations of the Paraenses with the outside world are all through the Pará River, which is the main channel, and the only one used nowadays by vessels visiting the Amazon, whether stopping at Pará or going farther up the valley.

M. A. de Belmar tells how ships coming up the Amazon to Pará avoid the *pororóca*. Prof. Orton says it rises suddenly along the whole width of the Amazon; while a writer in the Bulletin de la Société de Géographie (November, 1871) says it is washing away the shore at the Salinas lighthouse, southeast of the mouth of the Pará River. In reply to all this I have only to repeat that the *pororóca* proper is confined to the northern mouth of the Amazon, in the vicinity of the Rio Araguarý.

It is well known that the tide is felt as far up the Amazon as Obidos. Mr. Belmar has erroneously attributed this to the *pororóca*. One authority, in describing this phenomenon, represents the waves as breaking upon the rocks. I can say, from personal observation, that there is not a rock to be seen from a short distance below Macapá to near the colony on Araguarý. I can not speak positively of what may be found in the vicinity of Cape North, but I very much doubt there being many rocks exposed there, if any at all.

All that has been written upon this subject by persons having visited the theatre of its action in Brazil is limited to the notes of Condamine on the great *pororóca* of the Amazon and Araguarý,* to those of Bernardino de Souza,† and Dr. Alfred R. Wallace‡ on the small one of the Rio Guamá. Dr. Marques also gives something regarding its occurrence on the Rio Mearim, in the province of Maranhão.*

So far as I am able to ascertain, the *pororóca* itself in its greatest development has never been seen by a white man.

MR. WOODFORD, the traveler, says that, although the natives of the Solomon Islands have matches, they still make fire by friction on certain ceremonial occasions. Their method is to rub a hard piece of wood in a groove formed on a soft piece; but, though the savages would usually produce fire in less than a minute, the traveler himself "rubbed till his elbows and shoulders ached without ever producing more than smoke."

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* Voyage fait dans l'intérieur de l'Amérique, par M. de la Condamine. Paris, 1745, pp. 193–195.

† Lembranças e Curiosidades do Valle do Amazonas, pelo Conego Francisco Bernardino de Souza. Pará, 1873, pp. 126, 127.

‡ The Amazon and Rio Negro, by Alfred R. Wallace, pp. 114 *et seq.*, where it is spoken of as a "*pirorôca*."

* Diccionario da Provincia do Maranhão, por Cezar Augusto Marques. Maranhão, 1870, pp. 385, 386.

THE EXPERIENCES OF A DIVER.

By Prof. HERMANN FOL.*

THE Romans of the easy class dreamed of junketing in a villa with an outlook on cultivated fields. A hundred years ago the Alps were never spoken of without laying stress upon their terrors. Such facts show how different are the tastes and the ideals of this generation from those of our ancestors. In the present age of tiresome security, we have become amateurs of danger. One man scales the highest mountain-peaks without any other purpose than to taste for a few hours the rough pleasure of the struggle for existence. Another prefers risks that will contribute to the increase of man's scientific capital, and will leave something more than a simple personal recollection. I invite the exuberant forces of living youth to the exploration of the sea, than which a vaster field and one more capable of satisfying daring and curiosity of every kind can not be found. It is an exploration which, with all deference to cabinet naturalists, presents at once a great attraction and a high scientific importance.

I know persons whose ideal consists in getting preserved specimens, no matter how many, provided they are new. We call new a species that has not yet been dressed up with a Latin name, and which we have consequently a right to baptize with a word in a dead language, followed by the name of the baptizer. The harm of the matter is in the latter element, for, without that addition, the number of Latin names would be reduced by a half, and there would be no occasion to protest against authors who create a genus for each new species. Some find their pleasure in classifying and naming species. Others profess to despise that occupation. They prefer to dissect animals and describe their anatomy, without concerning themselves respecting the use to which the organs are fitted. Still others love to describe the development of beings, without knowing anything of the purpose of the successive organizations of larvæ and young; and they meet in the work anomalies that puzzle their brains. We understand the swallow, because we see its actions. But if there were naturalists living on the bottom of the ocean who had never been in the air, and who knew these graceful birds only through specimens preserved in alcohol, what brilliant zoölogical, anatomical, and embryogenical dissertations would they not make on the subject! I know many among naturalists occupying themselves with marine zoölogy who do not dive or swim, and whose science is of no more value than the swallow-science of our supposed submarine natu-

* Address before the Nautical Club of Nice.

ralists would be. We recognize their excuse. It is, that means of observing marine animals in life, aquariums, and especially the diving-dress, are not within everybody's reach. They cost considerable sums. The student needs a diving-jacket, a boat of considerable tonnage, and a crew of competent men, all to himself and under his orders; for freedom is a great element of success in all scientific investigation.

The diving-jacket is a more ingenious and more useful invention than many that make more noise. It is dangerous or safe according to the way it is used. It has come into extensive use. Every seaport, every war-vessel, and every large steamer has a diving dress and apparatus. Even sponge-fishers have recourse to it. Science, however, could derive no profit from the reports of professional divers; their veracity is below everything that could be imagined, and then they look without seeing. Although inhabited by millions of negroes, Africa remained unknown till educated white men succeeded in crossing it; the bottom of the sea will never be known till good observers have gone down there.

Students should descend themselves; but, unfortunately for science, persons are rare who have gone to see in place the animals concerning which they have written large books. They might have been spared many errors. Some have not the means; others are afraid; and still others have once gone down two or three metres, and then hurried to fill the press with the creations of their imagination; for the first plunge which one makes is of no value for the observation of things that are outside of himself. He sees thirty-six colors, and that is all.

This first plunge leaves no agreeable memories. They dress you as if you had to endure the cold of Siberia, a precaution which I have found useless in the Mediterranean. With knit woolen hose, cap, and shirt, I have never felt the cold. Then comes the ample coat, which we get into through the neck-hole, and the casque, which resounds as if one had his head in a kettle. Then they put on you a belt with a dagger, shoes with leaded soles, and lead at your breast and back. Now you are so loaded that you could hardly stand straight if the boat should tip—then you go down into the water where all the weight is no longer felt.

Now a different feeling begins. At the command, "Pump!" some one rapidly screws down the glass in front of your casque, and you hear a noise to which you have to accustom yourself—*pah! pah! pah!*—accompanied by a hissing of the air. Little whiffs of air come to you, scented with machine oil and caoutchouc. The beginner fails to manage the escape, and his coat and sleeves become inflated, so that, when he wants to go down, he floats like those frogs we used to blow up when we were boys, and then

throw upon the water to amuse ourselves with their vain struggles to get under it.

Then comes the gurgling of the water and air escaping through the valve, and you descend. The pressure immediately increases at the rate of one atmosphere for about every ten metres of depth. This increased pressure, which would be insupportable if it was unequally distributed, is hardly felt, because it is exerted in every direction. The air is reduced to half its former volume, so that our inspirations take in double the usual quantity. Instead of breathing more easily, as one would naturally suppose he would do, the diver feels an oppression which is very troublesome at first. But it soon passes away. It is caused by a pressure on the alveoli of the lungs which impedes the exchange of gases. But the equilibrium is soon restored spontaneously.

The most disagreeable sensation produced by the descent consists of pains in the ears, sharp and accompanied by a feeling of dizziness. It is caused by a pressure of the air contained in the medial ear; the tympanum is stretched and pushed upon the ossicles, till a bubble succeeds in making a passage for itself through the Eustachian tube. The pain then ceases, but returns as the descent is continued. After a few plunges, the Eustachian tube enlarges enough to let the air pass freely, and the pains cease. The dizziness is explained by the fact that the inner ear, as M. Delage and other physiologists have shown, is the seat of the sense of direction; so the novice does not know where he is, and imagines that his head is down. Mariners, in training for diving, are caused to go down first in a spot where there is hardly water enough to cover the casque; they come back with downcast features and the flurried air of a man afflicted with vertigo.

The most delicate point is the regulation of the air-escape. The novice lets out too much air, and water comes in by the valve, and the casque seems so heavy that he imagines he is nailed to the bottom. He then lets too much air accumulate, his coat swells, and the casque rises so much as to take the valve out of reach of the hand. Despite all his efforts to stay on the bottom, he springs up to the surface. The air, released from the pressure, expands, the coat is inflated almost to bursting, and he floats like a dead body. One can never be a good diver till he learns to regulate the air as a horseman holds the reins—without thinking about it. We might, indeed, adjust the valve for a particular depth, so that it shall act automatically; but the diver who desires to ascend and descend at will, will do better to keep the escape-valve taut, and regulate it with his head.

The beginner is not able to travel about as he wants to—first, because he feels too light or too heavy, according to the quantity of air in his coat; and, second, because the water offers an unex-

pected resistance to his progress. He sees things two steps away that he wants to get, and can not reach them.

Pictures show the diver walking along on the bottom of the sea as he would do on the land; it is a false representation. One can not get along without bending his whole body at an angle of forty-five degrees in the direction he wishes to go, and then pushing along on tip-toe in an attitude that would excite laughter in a beholder, assisting himself with his arms as in swimming. If the bottom is uneven, he will do better to creep on his hands and knees.

On the other hand, one can do things in the water that are impossible in the air—let himself drop, for example, from the rocks; the water will break the fall. Or, he can climb cliffs by letting a little air collect in his coat and planting the ends of his fingers in the cracks and rough places. On broken ground he can pass with a kind of flying leap from one rock to another. But all this supposes a degree of familiarity which is not acquired for a considerable time. In my first efforts I cut my hands terribly, and was not able to use my pen or pencil for several days. I tried a coat made with the sleeves ending in India-rubber gloves, but they prevented my picking up small things, and, moreover, did not last long. I then returned to the common sleeves, closed at the wrist, and used knit woolen gloves.

Another difficulty is occasioned by the glasses of the casque becoming covered with the vapor that results from the condensation of the moisture of the breath. The colder the water, the thicker the vapor is. No means as yet tried to get rid of it have resulted satisfactorily, but I have solved the problem by rubbing the glasses with glycerin. The mist then condenses in a uniform nap which does not obscure the glass.

When all these difficulties have been surmounted, there is still one that persists—that is, the effect and the danger of compression and decompression. That imposes a limit to the depth a man can reach with the diving-dress. Divers are liable to two kinds of accidents. One is a prostration on coming to the surface, for which restorative measures often have to be applied; and which, according to Paul Bert, results from the effects of the change of medium on the spinal marrow. It is rarely mortal, but may eventually produce a paralysis of the lower limbs. The other accident, graver but very rare, consists of a gaseous embolism of the capillaries of the lung, produced by the disengagement of bubbles of air in the blood, which has dissolved too much of it while under high pressure. The action is like that of Seltzer water at the moment of pressing on the pedal of the siphon. Under its effects, when it occurs, the diver dies as soon as he reaches the surface.

Both causes of accident can be avoided by descending and rising slowly. For this reason a steel chain may be used as a ladder, to be let down to the depth the diver has reached, by the aid of which he can stop at will while coming up. But the question of time comes in to limit the depth which it is possible to reach. If we allow three quarters of an hour for a diving excursion, a quarter of an hour will be required to descend below thirty metres, and as long to come up; so that only a quarter of an hour is left for staying on the bottom.

Of the scientific observations which I have been able to make with the diving-dress, I will speak only of those of a physical order; a book would not be sufficient to describe my zoölogical observations. When the water is transparent and the sun shining, we can, looking down from the boat, distinguish the bottom to about twenty metres; but for that the surface should be perfectly smooth. I have had fixed in the bottom of my yacht Amphiastre a light-port with a very thick glass. By darkening the cabin we can see through it clearly, farther than twenty metres, even when the surface of the sea is troubled. Seen thus from above, the bottom of the sea always looks flat. All the visible parts are equally lighted, and the appearance of relief is naturally destroyed by the absence of projected shadows. In going down in the diving apparatus, we are astonished at perceiving that the ground, which appeared nearly uniform, is really bristling with rocks and hollowed by deep valleys. The shadows are now visible, because the light coming from above, the parts under the projections of the rocks and the tufts of sea-weed are in the dark. If the diver looks up from the bottom through the frontal glass of his casque, he will see a great light, circular space that may be regarded as the base of an inverted luminous cone, of which the spectator's eye occupies the tip, and the apical angle of which is about 62° 50′. Beyond this circle the surface looks dark, presenting precisely the aspect of the sea as seen when looking down into it from the boat. The sky and objects in the air are visible only within the limits of the luminous circle. The borders of this circle are always more or less indented, for the surface is never perfectly quiet. The sunbeams are dimmed and come down in dancing showers as we see them in a room on the edge of the water when the blinds are drawn down, and the rays, reflected from the mobile surface, shine upon the ceiling of the room.

The decrease of density of the sun's rays is very rapid, and they are almost completely diffused at thirty metres. As the sun declines toward the horizon, a darkness suddenly comes on which has sometimes caused me to ascend very speedily, in the belief that night had fallen. Coming out of the water, I was astonished to find myself immersed in the rays of a sun not yet near setting.

There is an angle at which the proportion of rays reflected to rays refracted becomes so much against the latter that the illumination of the bottom falls off very abruptly.

The transparency of the water along the littoral varies enormously. In times of rain, it is clouded by swollen streams pouring into it; in dry and still weather it becomes nearly as clear as in the open sea. There are also capricious and sudden changes caused by currents from the land or from the open sea, which are capable of producing great effects in a few hours. Experiments on the penetration of light, to have any value, should be made very far out.

When the water is comparatively clear, it still absorbs so much light that at thirty metres' depth, if the sky is clouded, one can not see distinctly enough to collect small animals. In a horizontal direction one can not distinguish a rock more than seven or eight metres off. When the sun is shining and the water is very clear, we can see a bright object at twenty or even perhaps at twenty-five metres. But in usual conditions we have to content ourselves with half these numbers. These facts, verified many times in the descents which I have executed with the diving apparatus of my laboratory at Nice during the last three years, appear to me important from several points of view.

It is evident that a submarine boat can not see its way under these conditions. Slow as may be its movement, there will not be time for it to retreat if it sees some obstacle rising in front of it; for it would not be more than ten metres away from the impediment at the moment of perceiving it. It will always have to take its directions before going down, and to sail only upon a ground the relief of which has been carefully explored. Submarine navigation will thus always be confined to limits which the genius of man—since it can not change the transparency of water—will never be able to enlarge.

These observations are also of great interest from a biological point of view. We can see every day that agile marine animals living in the illuminated strata of the waters—fishes, lobsters, and cephalopods—are in the habit, when they are frightened, of giving themselves up to a very rapid flight and quickly stopping. They feel that a few metres are enough to put them out of the range of vision of their pursuer. Some even take the pains to add to the obscurity of the water by discharging their ink, as the squids do, or stirring up the mud, after the manner of many fishes. Marine animals may well be near-sighted; for of what use to them is a long vision when they can at most see only a few metres away? Hence their crystalline lens is bulged into a nearly spherical shape. They live in a world of surprises, and, as it were, in a perpetual fog. The nets we stretch for them would

hardly take any fish, at least in the daytime, if they could see as far as we see in the air.

The color of water varies from blue to greenish, usually according to the degree of its clearness. Objects at twenty metres' depth begin to take a bluish hue, and at from twenty-five to thirty metres the light is so blue that dark-red animals look black, while green and bluish sea-weeds seem almost white by contrast. Coming back quickly into the air, eyes accustomed to the blue light see the air-landscape red. The red rays are extinguished first, a fact which had been already demonstrated by laboratory experiments. The blue rays, being absorbed in a less degree, penetrate farther; and these are the rays which act most energetically on the photographic plate. This fact disposes of the objections which some students have repeated with a persistency that is not creditable to their ideas of physics, against the use of photographic plates in determining the depth to which daylight can penetrate through water.

When there is a swell, the diver's task is a hard one. He is constantly tossed about in spite of himself, and an irresistible force compels him to swing like a pendulum. This oscillation of the water, which is a counterpart of the waves of the surface, is nearly as perceptible at thirty metres as at ten metres. It can not be a surf phenomenon, for fishermen find that, after a storm, depths of fifty metres and more are swept by it. Special apparatus and experiments are required to determine to what depth it extends; but, in view of the incompressibility of water, I should not be astonished to find it extending very far down. In this matter, as well as in a great many others, the diver is in a condition to gain valuable information by which new avenues may be opened for the study of the phenomena of Nature.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

DRESS AND PHYSIQUE OF THE POINT-BARROW ESKIMOS.

By JOHN MURDOCH.

THE people who live on the extreme northwest corner of our continent are far from being an ugly or an ill-made race. Though they are not tall—a man of five feet ten inches is a tall man among them—they are well-proportioned, broad-shouldered, and deep-chested. The men, as a rule, are particularly well "set up," like well-drilled soldiers, and walk and stand with a great deal of grace and dignity. I fancy that a good deal of the erect carriage of the men comes from their habit of carrying the gun,

or in old times the bow, in a case slung across the back, by a string passing round the chest.

The women do not have such good figures, but are inclined to slouchiness, which they perhaps get from trotting ahead of the dogs when traveling with sledges. They are seldom inclined to be fleshy, though their plump, round faces, along with their thick fur clothing, often give them the appearance of being fat. They generally have round, full faces, with rather high cheek-bones, small, rounded noses, full lips, and small chins. Still, you now and then see a person with an oval face and aquiline nose. Many of the men are very good-looking, and some of the young women are exceedingly pretty. Their complexion is a dark brunette, often with a good deal of bright color on the cheeks and especially on the lips. They sunburn very much, especially in the spring, when the glare of the sun is reflected from the snow. They have black or dark-brown eyes and abundant black hair. The women's hair is often long and silky. When they are young they have white and regular teeth, but these are worn down to stumps before middle life is reached. Cheerful and merry faces are the rule, and they are altogether pleasant people to see and to associate with. The men cut their hair square across the forehead and comb it down into a regular "straight bang," with long locks on each side of the head, covering the ears, but clip a round spot on the crown of the head like a monk's tonsure, and a strip about two inches wide from this tonsure down the back of the head to the nape of the neck. They say that, unless the hair is clipped off on the crown and back of the head, the man will suffer from snow-blindness in the spring. The women part their long hair smoothly down the middle from the forehead to the back of the neck, and gather it into a braid on each side behind the ear. When they are dressed up, these braids are wound round and round with a long string of small, bright-colored beads, and the whole finished off with a flat brass button fastened into the hair behind each ear. They wear ear-rings, too, usually made of long glass beads, dangling from a little ivory hook which fits into the hole in the ear. They are all tattooed with one, three, or five narrow blue lines running from the under lip to the chin. The men are seldom tattooed, but instead, they wear the curious *labrets*, or lip-studs, which are peculiar to the Eskimos of the Northwest. These are large studs of stone or bone, like sleeve-buttons, which are buttoned into holes in the under lip, one at each corner of the mouth. At first sight, these ornaments appear a hideous disfigurement, but it is surprising how quickly one gets used to them. The most fashionable labrets, which are worn on "swell" occasions, are made of white marble in the form of flat disks, about an inch and a half in diam-

eter, with half a large blue-glass bead glued to the middle of each. Others are shaped like plugs, and are made of black, white, or gray stone. They used to pick up the stoppers of Worcestershire-sauce bottles that we threw away, and make labrets of them. All they had to do was to grind off the knob on top a little, to make it fit comfortably between the lip and gum.

Their clothes are made almost wholly of the skins of wild animals, though they sometimes wear outside frocks of calico or drilling. The skin which is most commonly used is that of the reindeer, which is perhaps the best material that could be found for clothing in a cold climate. It is very warm and at the same time very light, and can be had of various thicknesses, from the short-haired fawn-skin, fit for making handsome thin clothing, to the heavy winter coat of the buck, suitable for blankets or thick clothing, to wear in the very coldest weather.

A man's full suit of clothes consists of a loose frock, with no opening except at the neck, provided with a hood that can be drawn up over the head, and a pair of close-fitting knee-breeches, tied down with draw-strings over the tops of the long boots. In cold weather a second frock is worn under the first, with the hair side next the skin, and an extra pair of breeches. On the feet are worn long stockings of thick deer-skin, with the hair next the skin, and outside of these the tight-fitting boots, which in winter are made of the short-haired skin of the deer's legs, with soles of sealskin tanned white, and in summer of water-proof sealskin, with the hair carefully scraped off without removing the black epidermis, with soles made of the skin of the bearded seal or the white whale. These boot-soles are very neatly crimped up all round the foot, like the soles of moccasins. The crimping is done with the teeth, which is one reason why the women's teeth wear out so quickly.

I know of no warmer and more comfortable foot-gear for a cold climate than the Eskimo fur stocking and deerskin boot, with the elastic pad of whalebone shavings worn under the foot, between the stocking and the boot as they wear it.

The man's frock is cut off square across the skirts, and reaches about to the middle of the thigh. The women wear a good deal longer frock, which comes down in two rounded flaps, one in front and one behind, nearly or quite to the knees. This frock, too, is made looser in the back than the man's, so as to make room for the mother to carry her little baby inside, and there is a special bulge in the hood just at the back of the neck to make room for the youngster's head. Instead of breeches and boots, the woman wears tight-fitting pantaloons all in one piece with the shoes, which have soles like those of the men's boots. These pantaloons are made of deer-skin in winter, but in summer they are made of

the same stuff as the men's water-proof boots. The men sometimes wear pantaloons like the women, and the boys all do till they arrive at manhood and have their lips pierced for the labrets. The boys wear jackets like the men's, but the little girls' dress is a perfect miniature of the women's, even to the pocket at the back of the neck for the baby's head. Indeed, the larger girls sometimes do duty as nurses, and carry round their little sisters in their jackets like grown women.

The usual material for jackets is reindeer-skin, prepared without any process of tanning. The skin is first dried in the sun, and then the stiff under membrane is carefully scraped off with a very effective tool made of a small piece of flint chipped into a blunt blade, and fitted into a handle of ivory or wood, shaped so as to fit exactly into the hollow of the hand. This scraping also serves to soften the skin, just as you soften a sheet of stiff paper by rubbing it up, and the skin is finally finished off by rubbing it with pumice-stone and gypsum or chalk. When the skin is finished the inside looks and feels like white wash-leather, but, of course, is easily spoiled by wetting. All sorts of skins that are to be used with the hair on are dressed in this way.

To make a frock of ordinary thickness, they usually select the skins of does in their summer coat, one for the front and one for the back, and put them together so that the best part of the skin, on the back of the animal, comes on the front and back of the person where it will show, while the poorer skin from the belly is concealed under the arms or the sides. The head of one skin is made into the hood by fitting it in with seams. All these garments are made on regular patterns, just as our clothes are; all jackets, for instance, having practically the same number of pieces. To make the frock fit round the neck, there is a curved triangular piece let in on each side of the throat, and these throat-pieces are always made of the white skin from the belly of the deer, no matter what is the color of the rest of the garment. This gives a very pretty effect to the frock.

Heavy frocks for very cold weather, especially for wear when out on the ice seal-hunting, are made of skins of deer in the thick gray winter coat. Now and then you see a frock made of the Alaskan variety of the mountain sheep, which is of a pale buff color, almost white. Full-dress frocks are also made of the white or variegated white and brown skins of the tame Siberian reindeer, which they get by trading from the Eskimos whom they meet in the summer at the mouth of the Colville River. The latter get them from Kotzebue Sound, whither they are brought from Asia across Bering Strait. These skins are highly prized.

There was one old fellow at Cape Smyth who was a very great

dandy. He owned, among other fine clothes, two very "swell" frocks, one made wholly of ermine-skins put together in stripes of brown summer skins and white winter skins alternately, with the tails and feet dangling, and another of blue and white fox-skins put together in alternate stripes.

The every-day frock has very little trimming except a fringe of wolverine fur around the wrist, and a strip of long-haired wolf-skin round the edge of the hood, so that, when the hood is drawn up over the head, the long hair stands out all round the face like a halo. This is not merely an ornament, but also serves to protect the face against the wind. Working frocks are often without even this frill. Full-dress jackets are often very prettily trimmed with edging made of alternate strips of light and dark skins, fringed with wolverine fur, and often ornamented with little knots of red worsted.

The breeches are usually made of heavier deer-skin than the frock, so that only one pair is more often worn than a single frock, and then with the hair inside. Full-dress breeches are tastefully trimmed with edging like the jacket. The boots and the women's pantaloons, as I have said, are generally made of the skin of the deer's legs, and it is the fashion to have the white patch from the inside of the deer's leg always on the outside of the ankle. A specially fashionable style of boot has the leg made of alternate stripes of white and brown skin, with a very pretty effect. Women's pantaloons also are often made this way below the knee.

Eskimo dandies, instead of having their boots kept up by the draw-strings of their breeches, have the tops finished off with a fancy edging, and kept up by draw-strings of their own. To keep the moccasin-like sole of the boot from getting out of shape and running over on one side, there is a pair of strings fastened to the edge of the sole near the heel, crossed over the instep, and tied round the ankle.

There are several kinds of material used for making boot-soles, and each is supposed to be specially suited for some particular purpose. For walking on dry snow, the best boot-soles are made of sealskin which has been rolled up and allowed to "heat" and ferment a little before drying, so that the epidermis can be scraped off with the hair. This looks like cream-colored morocco and will not stand the least wetting. For walking on the rough sea-ice they prefer to have soles made of sealskin dressed with the hair on, and worn with the flesh-side out; but for their water-proof boots they use the thicker skin of the great bearded seal, or, if they can get it, of the white whale, dressed with oil. Sometimes the skin of the polar bear is made into water-proof soles. The white whale skin is the best material. It makes a translucent,

honey-yellow leather, about an eighth of an inch thick, stands the water very well, and is quite durable.

Under the outer pantaloons the women wear a second pair of thicker deer-skin, skin-side out, with stocking-feet. When the spring comes, and the snow gets sloppy on the surface, they discard the outer pantaloons and put on water-proof boots like the men's, but held up by a draw-string just below the knee. Later in the season, when there is a good deal of wet weather, and they are knocking around in boats, they wear pantaloons made wholly of water-proof black sealskin. All these pantaloons, like the men's breeches, are rather short in the waist, and are held up by a girdle just above the hips. Like a sailor's trousers, they need a good deal of hitching up.

The frock is always confined round the waist by a girdle, often merely a strip of skin. The men, however, often have handsome belts about an inch and a half wide, woven of the shafts of feathers. By using black and white feathers a very neat pattern is produced. The fashionable ladies' belt is made by sewing together bits of fur from the feet of the wolverine, each with a single claw attached.

Fastened to the belt behind, every man and boy wears the bushy tail of some animal. A wolverine's tail is the "correct thing"; but those who can not afford this wear the tail of the wolf or the Eskimo dog. This fashion gave rise to the story, told by the old Russian voyagers, of men *with tails* on the American coast.

It is also very fashionable to wear the skin of an ermine dangling from the frock between the shoulders, or an eagle's feather in the same place or on the back of the hood. These are amulets, and are supposed to bring good luck, like the dried birds' heads, bear's claws, and other such things which the men wear dangling from the belt.

The only head-covering is the hood of the frock, which comes forward just far enough to cover the ears. In very cold weather, or when they are sitting on the ice watching for seals, the men wear cloaks of deer-skin over their other clothes. When it rains, or when they are out in the boats in rough weather, both men and women draw over their other clothes a frock made of strips of the entrails of the seal dried and stitched together. This frock has a hood which fits close round the face, and is quite water-proof.

Since these people have had so much to do with the white men, they have taken to wearing a good deal of bright-colored calico. Of this they make long frocks without hoods, which they wear over their furs in blustering weather to keep the snow from getting on to them.

Of course, in such a climate, the hands need to be well protected, and they have first-rate gloves and mittens. The gloves are always made of dressed deer-skin, with the hair-side in, and usually have a fringe of wolverine fur round the wrists. They are specially meant for dress occasions, and are often tastefully ornamented. The common, every-day mittens are made of thick deer-skin, and are always worn with the hair next the hand. Both men and women, particularly the women, when they have no work to do that requires both hands, have a great habit of wearing only one mitten, and drawing the other hand back through the sleeve inside the jacket for warmth.

In very cold weather, particularly when hunting or traveling, they wear very thick mittens made of the shaggy hide of the polar bear. These keep the hands very warm, and one of these mittens held upon the windward side of the face makes a capital screen against the sharp wind. The long, harsh hair, too, makes a first-rate brush for dusting off frost and snow from the clothes, and for brushing up the floor. When hunting with the rifle in winter, the hunter wears a pair of thin deer-skin gloves under his mittens. Then, when he is ready for a shot, he slips off his clumsy mittens, and can handle his gun without burning his fingers on the cold iron.

Of course, all these clothes are made by the women, who cut them out by their eye very skillfully, using their favorite tool, a broad knife shaped like a chopping-knife, which they use for cutting everything, from their food to a thread. This is better than scissors for cutting furs, because in cutting from the skin-side you cut the skin without cutting the hair.

For sewing skins they make their own thread by stripping fibers from a piece of dried sinew, but use nowadays steel needles and common brass thimbles. They do not sew as a white woman does, but wear the thimble on the forefinger and thrust the needle through from left to right. In old times their needles were made from the small bones of the reindeer's legs, and they used thimbles made of a bit of sealskin, in the shape of a ring with a pad on one side to press against the needle.

The great time for making new clothes is in October and November, which are named in the Eskimo calendar "the time for sewing" and the "second time for sewing." All summer long they have been living in tents and knocking round outdoors, and their clothes have grown pretty shabby and dirty. Now they have come back for the winter, and the time has come to make new clothes. But deer-skin clothes must not be made in the village while the hunters are out after seals, for that would bring bad luck; so the women take their work out into little tents pitched some distance from the houses.

By the time December comes, and with it the season for the winter festivals, everybody in the village has his new clothes for the year, and all look neat and trim in fresh brown deer-skins and clean white mittens and breeches.

PRAIRIE FLOWERS OF LATE AUTUMN.

By BYRON D. HALSTED,
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IT is not easy to satisfactorily decide why some plants bloom in autumn, while others produce their flowers only in spring. To have hepaticas in April is as much a matter of common expectation as for August to bring the first golden-rods and October a gorgeous display of asters. An unwritten law of Nature has been conformed to, and the result is a floral time-piece of the seasons, so accurate in its wonderful mechanism that one only needs to see the bouquet of a school-girl returning from her Saturday afternoon ramble in the woods to know the month of the passing year. Some time ago (The Popular Science Monthly, May, 1887) the writer prepared a paper upon "Prairie Flowers of Early Spring," in which it was stated that the first blossoms of the season gained an advantage by being first. There is a mutual adaptation existing between flowers and insects that the most casual observer can not gainsay. It is not only an advantage, but in many cases a positive necessity, that flowers be visited by insects in order to secure that transfer of pollen from one blossom to another which results in fertilization. The modern accepted view of all floral display is that it serves the purpose of attracting insects, and acts as a contrivance by means of which the fertilization of a flower by its own pollen is prevented. Botanists of earlier days did not force this truth upon the attention of others, and many persons better qualified to judge of human than natural history arrived at the erroneous, if not somewhat selfish, conclusion that floral forms and colors were primarily to beautify the earth and render it a pleasant habitation for man. No one can for a moment doubt that flowers are beautiful, but beauty is a secondary matter so far as the gratifying of man's taste for beauty in forms and colors is concerned. It is so planned that the qualities which render the floral structures so well adapted to the peculiarities of the insects are the ones which at the same time render them beautiful and thereby contribute to the pleasure of man. In this adjustment we may see the working of an Infinite Mind able to combine the two elements of utility and beauty so completely that it is not extravagant to say they are often inseparable.

In the present paper the reader's attention is invited to some of the plants that continue to bloom after the fingers of Jack Frost have silently pulled down the dark curtain of the waning autumn and shut out the warmth of vitality from all the tender sorts of vegetation. The first day of October opened upon a landscape of varied hues, some of a most somber character, for late in September the leaves of the box-elder, for example, had been blasted by freezing and the vineyards were prematurely brown with the curled and dying foliage rustling in the breeze. Corn and other plants of a like subtropical nature, not previously harvested, were stricken lifeless by the low temperature, and house plants carelessly left out of doors melted away into a mass of rapid decay. As one looked about him the scene could but remind the observer of the Scripture injunction concerning the two women grinding at the mill. Two plants side by side had been growing with equal vigor, and both bespoke an equally long life, but one was taken and the other left. The reason for this is not easy to find.

Many mysteries flood the mind in contemplating the world of vegetable life, but none more thoroughly baffles the keenest observer as well as the most penetrating microscopist than that of hardiness. We freely use the word in ignorance, or worse, to conceal our ignorance, as physicians may employ longer terms among their admiring, awe-struck, ignorant patients, but when the thoughtful pause comes it brings us face to face with a half-clothed skeleton that nearly frightens all save the brazen-faced. We may attempt to explain the real meaning of hardiness in a dozen ways, and in the very offering of so many reasons we exhibit the weakness of all the arguments. If we say that it is due to denser structure, the statement is met with the bald-faced fact that the hardiest plants do not have necessarily the denser tissues. A box-elder, which is considered a type of hardiness, yields a wood less than half as heavy as the hickory. Of the sixteen sorts of trees in the United States with wood heavier than water, all are in the warmer portions of the country, where no winter tests their hold upon vitality. Perhaps it is as much the plan of one species to have its twigs killed back as it is for another to withstand the sudden changes of temperature and the severe cold. It demands a more than human penetration to decide that the horse-chestnut, with its large and well-protected terminal buds in autumn, is better adapted to its conditions than the raspberry, with young, immature wood and imperfect buds, which die before the spring-time comes. The two are working out the problem of existence along widely diverging lines. The tree grows slowly and builds for a century, while the bramble forms only transient stems and runs its chances of making all it can out of a favor-

able growing season. No one would care to say that a Rubus is less hardy than an Æsculus. They are not to be compared, and there the matter ends. If two species in the same genus have similar habits of growth, and one fails to bear the surrounding conditions while the other thrives, the case is very different, and it is more natural to seek the reason, for the answer, if it could be given, might be a blessing to every orchardist and gardener suffering from losses among his tender plants. And even here it may be that the explanation turns upon surroundings to which each plant has been subjected. We know that species migrate from the home of the parent as birds from the parental nest or the sheep from the fold. It is not difficult to believe that offspring from common stock in time develop progeny subjected to very unlike conditions. Under dissimilar circumstances they develop unlike tendencies; and when, after centuries, these new forms are again brought together through man's culture, while they may be outwardly the same, the one is tender while the other is not. It is a question of the resistive power which, whenever we reach for it, whether with the high-power lens or the chemist's test-tube, the result is much the same. This generation seeks after a sign, and it might do many worse things. It may be a long time before there will be a better test for hardiness than that which is applied when a plant is subjected to the actual conditions. At present there is no rule without innumerable exceptions, which not only "prove the rule," but prove that it is valueless. The Greenlander may easily fall a victim to smallpox, because, we say, his system has not been so situated as to develop the resistive power to this direful malady. The Northern man goes south and is stricken with a fever that does not cause death to those "to the manor born."

In the field we see the corn falls with the first hard frost, while the asters along the roadway hold their freshness and continue to blossom until early winter congeals the sap. Turn to the flower-garden, and we see many of our tender plants in the withered brownness of death, and by their side stands the Anterrhinum in the beauty of its pristine freshness, bearing its blossoms of every size from the minutest bud up to the full flower. The pelargonium has its dead branches intermingled with the living stems of the petunia. The moss-rose is lifeless upon the ground, while the prostrate verbena is fragrant with new blossoms. Snows come and go long after the Indian summer has been succeeded by the chill November days, and the pansies smile from among frosty fallen leaves. Death and life are closely associated, and, while we can not comprehend it all, there are few who would lose the exhilaration of a prolonged search for the sake of knowing it all at once.

Along my daily pathway have thronged the shepherd's-purse and the purslane. The former passed the winter as seedlings from self-sowed seed in early autumn, and closely hugged the frozen soil unprotected, or perchance benignly covered with a blanket of snow. When the November blasts are howling and whirling down the snows, some belated plants—or, more properly, some hasty specimens ahead of their time—are left blooming alone. The pepper-grass (*Lepidium virginicum*) is closely related to the shepherd's-purse, and has the same times and seasons and habits of growth. On the other hand, the hot-blooded purslane, which was able to sprawl at full length upon the superheated ground in August, and thrive, to the great annoyance of the tidy gardener, falls a lifeless victim at the first firm grasp of the frost-king. In its obeseness it blackens with the rising sun, and soon leaves little else behind except the thousands of almost microscopic seeds, for which the icy winter only seems to serve as a fitting introduction to new activities when the long-delaying spring arrives. Look into the vegetable garden, if you please, and recall the two classes of plants therein grown for the table. There are sorts, the seeds of which may be sown as soon as the ground can be worked; while other seeds are of the tender sort and can not be committed to the earth until the settled weather has come and the danger of the laggard frosts is past. Toward the end of the season there is a like distinction. In short, some of the garden favorites must make all their growth during warm weather, and perish with the frosts of autumn; while others can be gathered at pleasure, even left in the earth until the following spring, and improved by the seeming neglect. Of meadow and pasture crops there are few that flower later than the red clover. This may be found in full bloom until the snows cover the melliferous heads for the balance of the year. The alsike also is a late bloomer, but the white sort gives up much earlier.

Let us turn now to the wild plants which are in flower upon or after the first of October in the climate of central Iowa—a prairie region—where autumn is more than past its middle by that date. At the outset, it is manifest of the plants in flower that a large number belong to the sunflower family. Among the most conspicuous are the asters and golden-rods, and the most beautiful of them all is the *Aster Novæ Angliæ*. This is a common species, and because at home in New England—as the name indicates—is none the less attractive, and one, the charm of whose purple rays of the large heads never flags. I have been upon long tramps through the low meadow-land where this species is the chief blossom, and never tired of the variability which the many plants exhibit. The leaves are clasping as if a strong affection existed between the blade and the stem from which it sprang.

Intermixed with this most richly attired of all the asters is the Riddell golden-rod (*Solidago Riddellii*); quite different from all the other Solidagos in having the stems clothed with long, smooth, narrow leaves, which gradually curve upward and then describe a half circle downward. The large clusters of flowers in the medium-sized heads have a depth of auriferous color which can not fail to attract all lovers of yellow. The golden-rod most nearly like the above is *Solidago rigida*, an earlier bloomer but holds its own against the early frosts. As the name suggests, the stem is large and stiff or rigid, the leaves are sessile, large, thick, and the heads of the blossoms form a broad, flat-topped inflorescence, standing three or more feet from the high, dry prairie soil. Among the other golden-rods were *Solidago speciosa* and the altogether common and yet far from the least attractive species, *Solidago canadensis*. This furnishes a serious puzzle to the careless student, but the lover of slight differences in plants finds in this species with its various varieties a subject of absorbing interest. *Aster longifolia* and *A. multiflorus* vie with each other in making the waste places bright and attractive during the October days, and exhibit their powers to resist the destructive agencies of the closing days of autumn by shaking their leafy stems and bright fresh heads of blossoms in the storms of bleak November. The three asters already named are among the last of all the prairie flowers, and seem to be full of life when the streams are icy in the morning and the sunny side of a log is a favorite haunt of the birds of winter.

Along the small brooks and over the lowland, where the fog damp and chill settle at early sunset, the great sunflower (*Helianthus grosse-serratus*) may wave its head, while around it is the retirement of the winter condition. *Helenium autumnale*, with its handsome heads, with lemon-yellow notched ray flowers and peculiar velvety decurrent leaves, is not common but attractive. We do not wonder that it lingers in the lap of early winter, because the atmosphere of its whole being is one of endurance, but of the quiet sort befitting the Quaker and not that of the bully.

But there are many late autumn plants scattered through other than the sunflower family. Along the streams and standing knee-deep in the wasted and decaying rubbish of the borders is the long, leafy stem of the *Physostegia virginica*, with its slender spike of showy rose and purplish-white blossoms. It is one of the mints in all save the minty quality, and for this peculiar lacking it is often a source of trouble to the tyro in classification. The flowers are complex, the stamens possess an abundance of hairs, in which the circulation of protoplasm may be seen; and, besides, insects visit them.

Of a very different type, perhaps more showy and certainly as interesting to the student of floral structures, is the great blue lobelia (*Lobelia syphilitica*), a frequenter of all low places, where its rank growth and bright deep blue render it a prominent object. This plant with its insect attendants has often furnished amusement for me by the half-hour. The insects seem always in haste, and dodge in and out of these blossoms with a methodical rapidity, each time receiving a new invoice of pollen to be scattered upon the stigmas of other blossoms subsequently visited. Among the most seemingly out-of-place blossoms as to time of appearing were those of the common blue violet. This is strictly one of the spring flowers, but with us for years it makes a second advent, and in some places blossoms so freely as to be no rarity. It has been used for classes of a hundred members for dissection in October. This favorite plant is not as well known in habit as it deserves. Its underground close-fertilized flowers, for example, are unseen, therefore passed by by those who only pick the showy aërial blossoms. The little low, round-leaved mallow, or prostrate mallow—in my boyhood days we called it "cheeses"—is one of our October flowers.

It will be seen that a fair share of the late autumn blossoms are weeds and useless plants. The May-weed (*Anthemis cotula*) is one of those which, if less common and without its rank odor, would be a very attractive plant in both foliage and flower; but, as it is, no one is anxious to give this wayside intruder any high place among the purely ornamental species. In like manner the mullein, or "great American velvet-leaf" as it is sometimes called in Europe (*Verbascum thapsus*), is a plant with some inherent attractions; but, owing to its obtrusive habit, combined with a coarseness and boldness, it can only rank with the weeds. It will accommodate itself remarkably to unfavorable conditions and come up blooming under all sorts of rough if not abusive treatment. There is a strict military air to this plant as well as to one of its October associates in the pasture (*Verbena stricta*). Both have stems much straighter than some ramrods, and one time a friend, seeing the mullein in great abundance upon rolling ground, remarked that they were like ten thousand men marching up a hill. The species of liatris, or blazing-stars, are of the same strict habit but vastly more showy. We have three species of these charming rose-purple composites, all of which flower late in summer and remain to display their marvels of beauty long after the tender plants have served their time.

Among all the late blossoms there are none for which I have a greater fondness than the gentians. They come, with their mingled purple and blue, at a time when those colors have become unusually rare, for they are never common at any time of

year. Some of the species bear flowers that long seem upon the verge of coming into full bloom, and disappoint those who look for wide-open flowers. They are somewhat bell-shaped; into the plaited opening, otherwise nearly closed, the bee or other insect pushes its way in search of nectar and pollen. Upon the exit of the winged visitant the corolla again closes, to the exclusion of everything except its insect attendants. The most charming of all the species of this late-flowering genus is the celebrated fringed gentian, so named because its long corolla ends in a most delicate row of long, fine, hair-like projections, suggesting the heavy eyelashes of a beautiful girl. The tint of the whole blossom is a pure and delicate blue, caught, as it would seem, from some patch of October sky, margined by flecks of fleecy clouds. These gentians, as well as rich specimens of a cousin to the thoroughwort and boneset, with great clusters of pure white flowers, might be gathered any late autumn day, the former in the low prairie, the latter in the tangle of frost-bitten herbage in "the timber" along the water-courses. The boneset flowers suggested, in their exhibition of white, the approach of winter, when all the copse is covered with a mantle of snow and the stream is locked in the embrace of the frost-king.

One of the latest of the autumn prairie flowers—and one not found by me until drear November has come in the wake of Indian summer weather—is the ladies-tresses, an orchid of no striking beauty, but, in a region where orchids are rare and arriving after the eleventh hour, it has its full share of interest. The plants are single-stemmed, few-leaved, and the small, pure white flowers are so arranged upon the long spike as to assume a spiral inflorescence, from which fact the common name doubtless originated in the fertile mind of some imaginative lover of plants. If the witch-hazel had been a member of the prairie flora under consideration, it would have been in its place of honor at the close of this list; but, as it is, the orchid and the aster, the shepherd's-purse of the wayside and the prairie must vie with the pansy in the flower-garden for the last place in the floral calendar of the year.

The reasons assigned in a previous article for the early blooming of plants hold good here for those that develop their flowers late in the year, and can be briefly condensed into the expression that, in the experience of the species, it is probably found an advantage to be somewhat out of the season. A single store upon a side street may do as well as any one in the market-place, provided it is thoroughly accommodated to the situation: competition, or the absence of it, is likewise an element not to be ignored in the consideration of the time of blooming of flowers; and no one can but rejoice that all plants do not produce

their blossoms during the same day or week or even month of the year.

[The above article has been prepared from notes taken by the writer while occupying the chair of botany in the Iowa Agricultural College.]

THE DUK-DUK CEREMONIES.

By WILLIAM CHURCHILL.

RELIGION is a vanishing quantity in the western Pacific, and the farther west one goes by so much the more rapidly does this sentiment vanish; dogmatic theology and its practical profession are alike absent from the thought and practice of the dark Melanesian. Simplicity marks all the desires of this island savagery, and this same simplicity marks all the spiritual side of life; instead of wondering puzzlement over the hazy ideas of a great first cause, or a hereafter which may in some sort be molded by the conduct of life in the present, the remote islander limits his religion and the spiritual side of him to an ill-defined, scarcely acknowledged fear of the unknown. Worship he has none; even the idea of propitiation of the malign power has not yet occurred to him; and the most that he can conceive of is sedulously to refrain from naming this terrible unknown.

Another circumstance deserves note because of its interesting coincidence with this absence of faith. What internal connection there may be between the two, if indeed there be any, is most obscure, for the reason that these people are as yet little known, and are very chary of communicating any information concerning these two features of their life. It is noticed by the careful observer that just in proportion as the forms and formulas of religion disappear from the life of the savage communities he visits, so there is a marked increase in the prevalence and power of the secret societies which seem to take the place of priestcraft and kingcraft.

Melanesia presents a very long list of these associations of men who are inducted into some secret or other, who are threatened with the most severe penalties if they divulge any part of these mysteries to the profane, and who are provided with signals for the recognition of other possessors of the same mysteries; and in more than one instance it has been observed that these signals have been recognized and regarded by people on far-distant islands, speaking a dissimilar tongue, and so remote as at once to preclude any chance of frequent communication. The very existence of these mystic orders is as far as possible kept secret, and it is only by long and patient study of the people that even the merest out-

line of their methods can be ferreted out. That they exist and exercise a tremendous power over the people is certain; that they are more powerful in communities devoid of religion is a fact; and with almost equal certainty it may be said that these secret societies are in some way intimately connected with the practice of polyandry, which it is evident has only recently among the Melanesian races yielded to the present system of polygamy.

New Britain, at the most remote and the most savage verge of Melanesia, shows to their best advantage the absence of the religious sentiment and the development of the secret society. Both are well exhibited in the ceremony of the Duk-duk, which plays a large part in the life of the community. It has not often been seen by white men, for the reason that its performers or devotees are fierce cannibals, and of those few who have seen it none have been able to learn more than just what little they saw. The reasons for the ceremony and the rude symbolism which underlies it have been carefully concealed under the seal of the oath of mysteries, and have evaded the traders who have witnessed the presentation of the ceremony on the village green. That this account can go any deeper into the mystery than others is due solely to a happy chance by which the writer was received into one of the New Britain families, and was allowed to progress into the chief mystery by initiation in due form. The public performance of the Duk-duk will first need recounting.

Upon a day not previously announced to the people the ceremony takes place. It is early in the morning, and the people have not yet scattered to their customary occupations on the beach or in the jungle that lies behind the village; the chief stands at the door of his house, smoking and watching the knots of the villagers; by his side stand some of the elders of the village discussing petty politics; the women chatter loudly at the spring, and the children are noisy at their sport. Suddenly there comes the warning cry, "Duk-duk!" there is a sound of some one crashing through the canebrakes, and the scene at once changes. The men hurry to take their places at the doors of their dwellings, brandishing their weapons of warfare; the women shriek and rush for shelter; and the children scurry home in hot haste, stumbling and falling in their hurry, but showing all the signs of terror. The noise in the jungle grows louder and draws nearer, the last hedge of rustling canes is parted, and a strange figure appears running at the top of his speed.

It is the Duk-duk. Near the ground are seen the legs of a man black as tropical skies and a hereditary inclination could make them, shining with cocoanut oil, and in rapid motion, as of a man who runs and dances with wild pirouettings as he goes. With the flashing shins all semblance of manhood ceases; what the eye

sees is not a man but an animated extinguisher, a gigantic copy in reeds and grass of the tin cones with which a generation that had not yet struck oil was wont to put out its tallow dips. Ten feet high, this extinguisher prances through the village, rushing furiously at every house as though intent upon extinguishing all who might be within, stopping short at sight of the armed householder only to whirl high in air and dart away to the next house, followed by the armed man from every house he has visited. It is a mad dance, this speechless prancing of a rushy cone followed by a constantly lengthening queue of silent warriors grimly brandishing clubs and poising spears. From house to house it goes until every house has been visited. If the Duk-duk chance upon a man away from the shelter of his roof-tree, meet him crossing the village green, or lurking in one of the narrow alleys, he charges down upon him, and destruction seems imminent. The man thus met lifts his arms with certain symbolic movements of the hands and fingers; his sign is recognized, the cone dances back, the threatening clubs are lowered, and the stroller falls in at the end of the procession. If man, woman, or child thus met out of doors failed to give the proper sign the clubs of the warriors would fall and the extinguisher would dance upon the prostrate form, dyeing his feet and ankles and staining the long grasses of his disguise with the blood of the profaner of the mysteries. Sometimes it happens that some man not deemed worthy of initiation is caught unawares before he can gain a place of refuge, and in every such case the full penalty of death by clubbing is exacted.

Sometimes a man met out of cover gives the proper sign, but the Duk-duk still dances before him, and the warriors still threaten but do not strike. Two others then leave the line and stand by the side of the man thus menaced, always one of the boys just growing into manhood; together they all three give the sign, the disguised fugleman and his tail dance away in search of other victims, and the two sponsors lead the lad away to an inclosure near the woods on the outskirts of the village.

The dance is done with a final flourish before the house of the chief, who would be chief no longer if he incurred the enmity of the Duk-duk; the stragglers have given the proper sign and have joined the dancing queue, or been led away by their sponsors, or else they have not hailed the mysterious visitor in the due and ancient form, and lie bloody where they stood, mere dead things. There is a flourish before the chief's house, and then the dancers, still strangely silent, follow their leader by the most direct route to the inclosure of high palisades where await them all such as they have met who have required sponsors; there is always one such, frequently more; for it is generally for the purpose of initiating these candidates into the mysteries that the Duk-duk

makes his visit. When the last dancer has entered the inclosure, a thickly woven hurdle of canes is tied at the gangway, the dancers prance in a constantly narrowing circle about the novitiates, threatening them with clubs and spears and sharp stone axes. At last the dance is finished; the chief seats himself at his appointed place, where a small mat lying on the ground marks the spot; the dancing extinguisher gives over his dancing for the first time since he burst in upon the village, and stands behind the chief; the others stand along the stockade except that side opposite the entrance; the novitiates stand in the center, and their sponsors form a little group a few feet away. When all have taken their places, the deeply masked figure moves toward the novitiates, no longer with a dancing step, but so crouched that his legs do not appear beneath the cone of reeds, which thus seems to possess the power of independent locomotion. The young men again make the signal which has met with a certain measure of success, but this time no sponsors aid them. Before each in turn the cone rests motionless, and the chief, then speaking for the first time, cries out, "Let him be put to the proof!"

Obedient to the royal command, the two sponsors lead the candidate to the vacant side of the yard where the battered wall gives evidence that it has been many times put to the same use. The masked figure also moves to a position close at hand, where he can easily inspect the bearing of the young man under the ordeal. The sponsors then draw back some space away and each lets fly his spear, which whizzes by the novitiate and sings as it sticks in the wall not an inch away from the flesh. If the novitiate wince as the deadly weapons hiss upon him, the keen eye of the Duk-duk would notice it, and at a signal every spear in the inclosure would on the instant be hurled with unerring aim upon the candidate who has been found unworthy. Having successfully passed this ordeal, the candidate is conducted before the chief, and the sponsors fall back a step or two. With a quick glance from one to the other to get the time, they swing their clubs and let them fall as one upon the young man who is toiling over this rocky path toward an insight into the mysteries. If he bear this trial without a show of pain, he has passed all the tests that will be required of him. At a sign from the chief, the hurdle will be cast off from the gate, and the procession reformed will take its way still farther into the half twilight of the jungle. Meanwhile in the village the women and the men who have not shared the great mystery creep out from their houses in fear and trembling and pick up the victims of the masked figure's mystic vengeance.

This ordeal of the spear and club is not the only preparation of the young man for the mystery of the Duk-duk. When he

arrives at the age of puberty he is told that he can not take his rank as a warrior and a man of property, but must always remain a communal slave, unless he is hardy enough to sue for entrance to the light of the great mystery. The distinction is one that is plain to him, and he probably does not hesitate in making his choice, but applies to his chief to be prepared for that which is to come. If his prayer be granted, and that is discretionary with the chief, two men skilled in the mystery are detailed, under the title of "brothers of the wood and sea," to educate the postulant. They conduct him away from his home and to a secluded spot in the wilderness of jungle. Here the postulant is made to build a house and hunt a supply of food. At first he is examined in his bodily exercises and in his proficiency in the few arts of his savage life. From these material considerations his tutors pass to more recondite matters. They instruct him in the secrets of the sea and the forest, each according to his title. When the candidate can pass a satisfactory examination in this branch of his education, his tutors acquaint him with the history of his race and the list of its hereditary friends and immemorial foes. Last of all he is taught to fear the spirit of the hidden fire which from time to time boils up in the craters and rushes down the slopes, marking its path by hot ruin and stony destruction. This power he is taught to fear as one that can not be averted, and that he must always be mindful of if he will save himself alive. All this has consumed a month or more, according to the ability of the postulant to master the lessons set for him to learn. When he finally succeeds in satisfying his masters, the brethren of the wood and sea, they take leave of him.

"We have taught you now," they say, when the time has come for their departure, "much of that which you must know in order to become a man and share our mysteries, and all that it is our duty to convey. That which remains will be taught you by another who will come to you when he is ready, and until that time you must not leave this place, nor speak to any man, nor sleep nor eat. To-day you may have to eat anything you please, but remember that whatever you eat to-day you must never taste again, nor must you so much as speak its name. Choose, then, that which you will now eat for the last time, and eat well, for days may pass before he comes who shall teach you the rest." When the postulant has eaten, the hut is cleared of all that it contains, and the brothers of the wood and sea sew mats over the doorway before they go.

His meal over—the last of that particular food which he shall taste on earth—the postulant composes himself to await the coming of his new master. The day passes, and night comes upon him left alone in a dark hut, in the heart of the dismal wood, and

without fire or the means of making it. He remembers that he is forbidden to sleep, and, as he sits, expecting the coming of he knows not whom, his strained senses are awake to a chorus of unfamiliar sounds which bring him terror. The day comes, but brings no food, no water, no master. As the sun declines, and he sees ahead another terrifying vigil, he looks toward the door. Between him and food, fire, and home, hangs but a light mat, yet it makes his dungeon as secure as though forged of steel, for a *tabu* is on it. As the first night, so is the second; as yesterday, so goes to-day, only the hunger gnaws with a sharper tooth, the thirst parches the throat and mouth still more, and the nerves are set on edge through lack of sleep. The vigil of hunger, thirst, and sleepless eyes may last two, three, or four days; but when even savage endurance can bear up no longer, the master comes. He enters the house in all his glory of rushes and colored grass woven into a cone, and stands before the lad. Little wonder is it that, worn by his ordeal, he should fear this mysterious figure, which he has always been taught meant death to look upon. If his fears overcome him, he is initiated into the mystery of the club, which strikes but once, and there an end. But if he bears up bravely under the trial, the Duk-duk teaches him the sign of recognition, gives him a new name by which he shall hereafter be known, and bids him go to his own home, avoid his childish playmates, tell no one the lessons that have been imparted to him, but await the next visitation, when the Duk-duk will surely claim him, and if he passes the remaining trials will induct him into the mysteries.

The young man goes home, announces his new name, and by abundant food and rest recuperates from his recent privations. Meanwhile, the Duk-duk day is drawing nigh; the profane do not know when to expect it, but the initiated know it to be the day of the new moon, on which the mullet at dawn swim so near the surface of the water as to break it into ten thousand ripples. If, on this day, the fish swim deep at dawn, the ceremony must go over for another time, when these two phenomena occur together. If the fish swim high, the Duk-duk appears, the postulant makes the signal which has been taught him, his sponsors—the brethren of the wood and sea—answer for him, and lead him to the yard where he undergoes the final ordeal, and, succeeding, is carried along with the initiated to enter into the mysteries.

He is led to a path which is adorned with the marks of a stringent *tabu*, and here it is made known that this *tabu* is hereafter not binding upon him. By tortuous ways, winding in and out through the dense canebrake, the path leads to a large house screened from sight in every direction. Before the house and, indeed, all around it, is planted a stockade with one gate. Here

he is bade wait while the rest enter. At last comes one to the gate who bids him enter, having first made him undertake, under penalty of death, not to divulge to women, to children, or to the uninitiated, anything of that which he may see or hear within. Entering on this stipulation, he finds the yard crowded with the warriors of his town, who welcome him to their ranks, call him by his new name, and congratulate him on passing all the tests so well. When this social function is over, he is led onward to the door of the house, there to receive his martial equipment. As he enters the door he notices the Duk-duk extinguisher standing in a farther corner, and squatting before it some half-dozen of the most considerable men of his tribe, including the chief. The bow and arrows, the spear, the heavy club, and the short-helved stone axe are then given him by the chief, with a few words of counsel, bidding him use them as a warrior should, and advising him that, if he use them well, he may in time be chosen to sit within the house, while the others are privileged only to use the yard. Then another of the seated figures—he who has that day worn the great Duk-duk mask—arises and chants the mysteries, to which, at proper intervals, the initiated standing near the door respond by an answering chant, which has no meaning that they know; the words are in an unknown tongue, and have been handed down by tradition from they know not whom. From the sound of some of the words even in their mutilated condition, and from the frequent use of the remarkably significant word Saba, it is possible that this refrain preserves a trace of an ancient Polynesian migration over these islands, just as the Derry-down chorus in English is a Druidical remnant.

For the rest, the mysteries, which have very little interest for the white man, are merely a rationalistic rehearsal of a creed of unbelief. Everything which by the uninitiated is held as of particular obligation, is here chanted as something that the initiated must rigidly impress upon the profane, yet which for themselves they may disregard. The *tabu* is to have no force for them except the great *tabu*, with a flock of hair on it, and that they must not break through. All others they may transgress, if only they do it slyly, and so as not to raise public scandal among the women and the others who are bound by their provisions. They must teach the uninitiated that there are malign spirits abroad by night, but they themselves need not believe anything so stupid. In a word, they form an association for the purpose of playing upon the innocence and credulity of their fellows, and right bravely do they keep up the imposture. One only belief do they profess, and that is in the spirit of the volcano-fires, and even that is discarded by the inner degree of the Duk-duk, those half-dozen men who sit within the mystic house and dupe the initiates

of the minor degree as all unite to trick those outside. And the reason is this: the half-dozen members of the most secret rank profess to one another that no better system of governing a savage community could be devised than this ceremonial mystery of the Duk-duk.

THE SENSATIONS OF PLEASURE AND PAIN.

By Dr. E. HEINRICH KISCH.

ALL our sensations, from the most trifling pleasure to the highest delight, from the hardly perceptible discomfort to the keenest anguish, the whole gradation of manifold variations of feeling, originate from the propagation of excitations from without through the nerves to the central organ of the nervous system and to consciousness. The nerves are the conductors of the stimulus-waves which go to the nerve cells of curious terminal forms in the brain and spinal marrow; and every excitation that touches any part of those conductors releases a sensation, the pleasant or unpleasant character of which depends first upon its intensity. To a certain degree every moderately strong excitation affecting us is agreeable and begets a feeling of pleasure rising to lively delight. An excitation surpassing this limit calls out an uncomfortable feeling which passes into pain. A gentle stroking of our skin, for example, is enjoyed; a strong pressure upon it evokes an uncomfortable feeling, which, continuing, passes into pain. Harmonious musical tones please our ears, but discordant noises make us miserable.

That a stimulus striking the sensitive nerves should reach our consciousness as a pain depends not on the force of the attack only, but also on the delicacy of the nervous system, which varies with different men to a considerable degree. Thus, many persons having finely developed organs of those senses can smell and taste many things of which other persons can hardly conceive; and much that is painful to an over-delicate lady causes no inconvenience to the hardy, coarse rustic. Also in various conditions of disordered health the whole nervous system or part of the sensitive nerves suffers from excessive sensitiveness, in consequence of which insignificant affections cause agony.

Neuralgias, or pains in particular nervous tracts, may be brought about by various causes—by disease in the terminal ramifications of the nerves, from disorders in the nerve-stem, through illness of the brain or spinal marrow, or from some irritation affecting another distant nerve, transmitted to this one through the central nervous system by what is called a reflex process. The common expression, "nervous pain," conveys no distinction respecting the character or source of the affection; but to the phy-

sician it is a matter of great importance to determine the precise source of the affection and the means of contending with it.

One of the most common neuralgias is a pain in the eyes; it is felt in the region of the trigeminal nerve, and frequently becomes almost unendurable and very obstinate. It occurs usually in single attacks, which return at various intervals and last sometimes only a few minutes, and sometimes a quarter of an hour or more. The painful feeling, which may be described as that of a boring, piercing, stretching, or tearing, generally radiates from a circumscribed spot in the neighborhood of the nervous ramifications, in the region of the eyes, face, and lower jaw, and may extend to the neighboring nervous regions, to the back of the head, the arms, and the breast. It not rarely becomes so fearfully intense and rasping that persons afflicted with it act as if mad, tossing themselves violently around and crying out in the most heart-rending manner. To this are added disorders of sensation. The eyes become red, vision is troubled with specks and spots, the flow of tears becomes excessive, the hearing is dulled or vexed with hummings, and the patient suffers from an unpleasant taste and burning in the nostrils. Companion afflictions set in, like twitchings and cramps of the facial muscles, eruptions on the skin, swellings, and a whole list of other disorders. To these bodily woes are added mental depression, life becomes a burden, and the sufferers are sometimes tempted to suicide.

This neuralgia may arise from a variety of causes; from a cold, an unsound tooth, from general sickness, or from debility or exhaustion. It is sometimes connected with disorders of remote organs, as of the digestive system, and by reflex action from pains prevailing there.

Sciatica, or hip-gout, is another frequently occurring neuralgia, which has its seat in the hip-nerve and its branches, and is thence transmitted through the whole lower part of the system, from the pelvis to the toes. The pain is usually confined to certain points, and rises on motion, and often at night, to great heights. It is a disease of middle age, prevailing with men and women, and originates from a variety of causes. The hip-nerve is exposed by its situation to be easily injured by cold and accidents; and the affection is often brought on from stagnation of blood, disorders of the lower body, and internal diseases. It is very persistent, and may interfere with business activity and occasion sickness through many years.

These diseases are cited as examples. Many other nerves are the seat and starting-points of pains which after long continuance give rise to an exaggerated sensitiveness of the whole nervous system, to increased acuteness in all the nervous regions, by which sound thought and feeling are deeply disturbed. It is evident

that full attention should be given at once to nervous pains and the means of counteracting them. First, every pernicious influence which may directly exert an irritating influence upon the nerves should be removed; then the remote causes which manifest themselves by nervous pains should be dealt with.

The removal of a decayed tooth may cure a face-pain at once and forever; taking away a body pressing upon the hip-nerve may be a complete remedy for a sciatica. Like ends may be reached in other cases by a regulated way of living which will lead to improved digestion and a more healthy circulation. The simple operation of an aperient, as I have had occasion to observe at Marienbad, has sometimes at once alleviated nervous pains that had defied every sort of treatment for years. Yet we do not always succeed in elucidating the causes of such troubles and removing them.

In such case the task of the physician, seeking to alleviate the pain, is to reduce the sensitiveness of the nerves. Sometimes he seeks to attain that object by applying counter-irritants on the skin along the course of the nerve or in its neighborhood. Of such are mustard-plasters, Spanish flies, burning, and dry cupping. Electrical treatment constitutes one of the most important applications for curing sick nerves. With alleviation of the pain, weakening of the attacks, and quieting of the nervous excitement, it also often induces improvement and cure in desperate cases. The same is also frequently accomplished by the use of warm baths, such as may be had at many natural thermal springs, sulphur, and other medical baths. Sometimes, when the pains are refractory to the application of heat, cold baths, washing and rubbing are of effectual service; and the cold-water method not rarely achieves real triumphs in cases of long standing, particularly when the neuralgia is the result of a cold, and it is desired, by hardening the organs of the skin, to make them less sensitive to changes of weather. Local applications of cold in the shape of ice-bags, cold poultices, etc., afford effective means of reducing the supersensitiveness of a nerve. Sometimes drugs are necessary which have the property when introduced into the blood of increasing or reducing the power of feeling. These remedies are applied outwardly or inwardly, and many of them have been known from ancient times. Narcotics taken inwardly, like opium and morphine, should be used with great care, and reluctantly. Beneficial and even indispensable as may be the pain-stilling and quieting operation of these drugs, it must not be forgotten that the human organization easily accustoms itself to them, so that ever more frequent application and larger doses of them are demanded, and, at last, bodily disease and mental disorder are brought on through the general poisoning they occasion. The

moment when a man afflicted with neuralgia receives the morphine injection for the first time, to free himself temporarily from pain, may be decisive for his whole future life. It soon happens that the anodyne is resorted to, not merely for unendurable nervous attacks, but for every little discomfort, care, and grief, so that the veil of forgetfulness may be drawn over the unpleasantness and the pressure of the unwelcome reality may pass away in dreaminess. Thus the unhappy man sinks from step to step in the slough of opium-poisoning, from which deliverance is possible only rarely and with difficulty. Energy, the power of resistance, the sense of duty and pleasure in action are lost, and he becomes a physical wreck; indolent and indifferent, timid and uneasy, emotional and excitable, the unhappy man presents the most critical symptoms of what is called "morphinism." Similarly terrible consequences follow the habitual use of other quieting drugs, including the preparations of cocaine. Those, therefore, who suffer from nervous disorders can not be too earnestly warned never to use any such preparations, except in extreme cases, by the prescription of their physician.

Massage has recently played a considerable part among the remedies applied for the removal of nervous pains. Good effects are obtained in neuralgias which originate from colds or stagnation of the blood by means of the kneading and the muscular exercises which are implied in this term. The structures in which the disordered nerves branch out should be worked in all directions, but only by experienced, intelligent hands—with pressure, rubbing, kneading, shaking, and moving, in order to remove the disturbance. Rough handling by awkward persons, such as those to whom the process is too often intrusted, may do more harm than good. Health gymnastics is included among the movement cures which are resorted to for the alleviation of nervous pains. In many cases, too, the opposite course—complete rest—is prescribed for quieting the excited nervous system, for the reduction of oversensitiveness.

In desperate cases, where medicines and mechanical applications have failed, surgical operations are called in, to remove the pain by severing the nerves. The results which have been often attained by this operation justify its application.

The best protection against nervous disorders is found in sparing the nervous force; in avoiding overexertion of body and mind; in systematic practice of bodily exertion and muscular exercise; in a wise alternation of work and recreation, and in hardening the power of resistance of the body and steeling that of the mind; in everything that can protect our emotional nature against degenerating into sentimentality, our feeling into tenderness.—*Translated for the Popular Science Monthly from Die Gartenlaube.*

ANIMAL LIFE IN THE GREAT DESERT.

By WILLIAM MARSHALL.

THE surface of the earth, with its division of land and water, its diversities of climate, and its various elevations, offers to the world of plants as well as to animals a complexity of life-conditions to which their organisms are compelled to adapt themselves if they would even exist.

Few regions exhibit to so large an extent such even, uniform, and original character, as that vast desert expanse which stretches through southern Arabia and northern Africa from the Persian Gulf to the Atlantic Ocean. This uniformity is the result of the correspondence of the desert tract with the same degrees of latitude, and of its never departing from the subtropical regions. Since, also, the elevation of the land seldom greatly exceeds 3,000 feet, the temperature conditions, however much they may vary in single places in the course of a day, are as a whole more uniform than they would be in a similar tract running north and south, and marked by important elevations. The midday heat in the desert rises to over 120° Fahr., while at night the cold, in consequence of the rapid radiation, sometimes makes itself very unpleasantly felt, and in winter descends below the freezing-point. More unfavorable to the development of animal life than the temperature is the want of water, both running and standing, as well as the absence of rain and dew. Sufficient water and a thin surface soil are found only in the oases, which exercise an influence over the distribution of life like that of the presence of the numerous islands in the great ocean. Even including the oases, vegetation is very scanty; the immense territory of the Sahara, with an area of upward of 2,500,000 square miles, harbors only 560 species of plants; while the Japanese Islands, having only one seventeenth the area, 150,000 square miles, support not less than 2,745 species. Most of the desert vegetation is deficient in quality as well as quantity; the plants are sparse, generally small, with inconspicuous gray leaves, and often covered with sand. Many plants that are usually annual develop, under the influence of life in the desert, long roots reaching down to the ground water, and become perennial. Monocotyledonous plants are represented only by dry, tough grasses, like the *esparto*, and by a few palms in the oases. Woods, the chief resorts of animal life, are wanting.

Most of the scanty fauna is concentrated in the oases. The oasis of Bachariel, according to the French entomologist Lefevre, swarms with insects at certain seasons, which would yield a rich harvest to the collector if he would stay there long enough to

secure the varieties. On the borders of the deserts, where the cultivated land cuts into them, especially in the region of the Nile Valley and the Red Sea, organic life is fairly well developed. The broad valleys in those regions are changed after rains into green meadows, and in January the perennial plants in every mountain-clove and ravine are covered with foliage and flowers; and annuals spring up, affording a luxuriant flora from February till April. Day moths sport themselves, in few species indeed, but in multitudes of individuals. Along with them buzz numerous wasps and flower-visiting beetles, and in the oases the troublesome ants are associated with a series of insects whose larvæ are bred in the water. Dragon-flies appear in multitudes, often swarming like locusts, and miles from the water, and myriads of stinging flies for short periods make the sojourn of Europeans intolerable. The pests of the home are here too, and vermin that make life a burden even to camels.

Scorpions are plenty, both in the oases and the desert proper, and spiders abound at the opening of the rainy season. Especially is this the case with a little purple spider of a velvety sheen, of which, according to Nachtigall, the people of Bournou believe the red velvet of the Western countries is made. Little crustaceans are numerous in the springs, and one species (*Artemia oudenyi*) occurs so frequently in some of the salt lakes of Fezzan as to serve, with the larvæ of certain flies, as food for the people. Fish are found in the ponds and underground springs; but the last are individuals which have, as Carl Vogt has shown, only casually reached the springs through underground channels from surface waters; for they betray no sign, either in coloring or the structure of their eyes, that they were ever accustomed to constant darkness. Of double interest is a fish living in the hot springs of Tofra and Lafra, in Tunis; first, because it can bear a temperature of 167° Fahr. without injury, and also because it belongs to a genus of which the other species live only in the sea. A few small fresh-water mollusks are found here and there, and land shells of a class which are capable of enduring protracted drought in a passive condition, and reviving when it begins to rain, and thus afford a remarkable example of adaptation to life in the desert. Frogs and salamanders, which do not easily adapt themselves to an arid environment, can not exist under the conditions of life that prevail in the Sahara, not even in the oases. Some reptiles, birds, and mammals fare better there. These vertebrates, in fact, with insects, are the only animal inhabitants of the desert.

Nearly all these animals, from lions and gazelles to locusts, wear the yellow color of the desert sand, verifying the phrase of the Latin poet, "*Flavæ leæneæ arida nutrix*" ("Dry nurse of the tawny lioness"). The weakling is thus protected by a coat that

withdraws him from the lurking view of hidden enemies, while the strong beast of prey may conceal himself behind a rock, by the aid of the color of which he can the more easily steal unobserved upon his prey. Only such animals as fear no enemies display so conspicuous a color as black. "What strikes the traveler," says Carl Vogt, "when he comes to the desert from the coast, where the greenness of vegetation predominates, is the absence of all lively colors—of red, green, and blue, in the animals." The full-grown ostrich is white and black; it is so large and swift that it has nothing to be afraid of but mounted men, and its food is not of such a kind that it needs a protective coloring in order to approach it without observation. The great desert crow (*Corvus umbrinus*), in which the negro of the Soudan perceives and worships his "uncle," is strong enough to keep off all its enemies, and agile enough to seize its prey when it has once had its eye upon it. The beetles, too, of the desert are black; not the "black beetles" of the Mediterranean region, but other kinds such as often have bright colors or a metallic luster. Carl Vogt asserts that these beetles are defended by an offensive odor or taste, that they have highly arched wing-covers and a depressed corselet or a withdrawn head, and can feign death when they believe they are threatened. When driven into close quarters, they become motionless, assume the likeness of the excrement of gazelles or goats, and thus avoid pursuit.

The coloring of the other animals is often remarkably like that of the pebbly sand. Those creatures—beasts of prey, ruminants, and birds—which are not confined to the soil, but roam or fly around, are tawny, but sometimes striped with different tints. Fowls, larks, stone-chats, running and wading birds, do not form local races with clear or dark feathers, and have not the faculty of changing their color according to the background against which they may for the time find themselves. Another rule prevails with those animals which occur in districts of limited extent. The snakes and lizards of the desert, even when they are of the same species, wear different vestures according to their dwelling-places, while the colors of the same individual, of the lizards at least, are themselves changeable. The proverbial chameleon is not the only animal which is capable of unconsciously adapting its colors to those of its surroundings. Eminently accomplished in this respect are the plaice, while our brook-trout, frogs, and many lizards possess the useful faculty in a less degree. The spring-tailed lizard (*Uromastix acanthinurus*), which Carl Vogt observed in captivity, presented in darkness and the shade a dull-gray slate color with indefinite blackish marblings, but when exposed to direct sunlight became brighter and brighter, and at last appeared of a dirty cream-color, with small, deep-black spots,

resembling in its hues the fine desert sand mixed with black grain-pebbles. Another lizard of the Sahara (*Trapelus ægypticus*) possesses the same peculiarity in a higher degree. The property of changing color depends on the presence of certain dark cells in the tissue of the skin, called *chromatophores* or color-bearers, which, contracting, under reflex influences of the nervous system, permit the full display of the ground-color of the animal, or, expanding to a certain extent, overlie it.

The power of changing color also exists in insects, but less commonly. We more frequently find among them varieties which are distinguished by constantly different but always protective colors. Lefevre observed in the Libyan Desert curious praying-crickets of the same species as to other marks, which were brown on a brown soil, and a hundred paces away, on white fossil shells and fragments of limestone, were correspondingly white. They resembled the background against which they stood so much that the French naturalist could not detect them except when they moved. They had other peculiarities, among them wings so contracted that they could not fly; a phenomenon which is sometimes met among insects and birds inhabiting large territories and islands where they are but little exposed to pursuit. They have disused flight with advantage, for only a good flier can keep his ground under the conditions that prevail in such places. A weak flier would be taken by the wind and carried off helpless to destruction.

Sand-fowl (*Pterocles*) are represented by fourteen species in the Old World, and are spread from the deserts and steppes of central Asia and India through all continental Africa. They visit southern Europe as breeding-birds, crossing the Strait of Gibraltar into the Iberian Peninsula. Their home is never in wooded regions; the more barren, stony, and arid the land, the less the extent of water and swamps, or contrast of mountain and valley, the more agreeable it is to them. In such regions live these modest birds, on the little which the land affords them, often on the sparse halfa grass; yet they can be found in coveys of hundreds, in places where it seems a puzzle how anything can live. Only ability to move speedily from place to place can make this possible. None but accomplished fliers can exist under such circumstances, and then when gathered in large groups. "It is easy for them," says Brehm, who has observed them more closely than any other naturalist, "to execute a flight, before going to sleep, which would appear to us equal to a day's journey or more." At breeding-time the coveys separate into pairs, and live in this state for a considerable period. When the brood is hatched they are still confined to their household duties, and, not being able to roam around, many suffer for want of the food which their narrow domain does

not afford. Life in the desert is, therefore, one of the factors by which the sand-fowl is forbidden the polygamy affected by other members of the gallinaceous family. Scarcity of food also affects the life of these birds by adding to their hours of labor; for they require more time to find the quantity of food they need than other birds whose tables are more richly furnished, and may often be seen, when the moon is shining, active during a part of the night.

Their plumage is strikingly like the soil of their home, though I doubt if they are aware of the value of the feature, as Brehm believes. The squatting attitude and the stillness they assume when they believe themselves in danger are probably only instinctive. Bitterns in like manner resemble in plumage, and in the position they assume when they perceive anything suspicious, the old reeds and bushes on the shore. I have observed the same changes in captive birds when suddenly frightened, and when it can not be of any use to them. It is an involuntary reflex action, like the bristling of the hair and the exposure of the teeth in angry dogs.

With extraordinarily acute sight and hearing joined to a great power of flight, the sand-fowl is little exposed to danger, except when a desert fox or fennec succeeds in stealing upon a covey at their noon-rest, or at night, and snapping up one or two of the number.

This animal, which is a little larger than a cat, is a true child of the desert, and is represented by local varieties through all Africa. Its color is the characteristic yellow of the desert; it has a fine growth of hair on the paws, which prevents its sinking in the fine sand and muffles the sound of its footsteps. The most striking of the features that have adapted it to its abiding-place and its way of life is in a certain sense the complement of its soft foot—a very sharp organ of hearing, the sound-catching outer part of which is unusually large. Its eye is not adequate to perceive its favorite prey, so well protected by its color; and there is a limit to the development of the organ of sight in an animal which, while it does not shun the day, is eminently nocturnal; and, as is often the case, another sense, that of smell, comes in, besides the hearing, to take the place of sight. Hearing is the night-sense; and the fennec can hear the slightest movement of the sleepy *khata* (*Pterocles alchata*) at distances almost incredible to men, and slip upon its prey with noiseless steps. Then a leap, and one of the little sleepers, before it is aware of what has taken place, has breathed out its arduous but not unpoetic life; while its companions rush away affrighted, with loud cries of "khadda, khadda!"—*Translated for the Popular Science Monthly from Daheim.*

ADELBERT VON CHAMISSO AS A NATURALIST.*

By Prof. EMIL DU BOIS-REYMOND.

IT is one of the lamentable consequences of the rapid expansion of human knowledge in this century that, while the power of comprehension and the adaptability of individuals continue essentially the same, the division of knowledge and mental labor is ever increasing. The paths which scholars and investigators follow are constantly becoming narrower, tending toward more contracted goals, and more distinctly separated; and in our historical view of recent times we regretfully miss such Briarean giants as he whose memorial day we are celebrating. Men like Leibnitz not only give by their wide vision and comprehensive power a conception of the human intellect in its highest manifestations; not only does a mutual fructification of different departments of knowledge take place in their minds through the meeting of different views; not only do they form, like an academy, a bond of union between accomplished labors in widely separated regions of knowledge; but, while they extend its efficacy in many directions more accessible to the common people, they create a wider participation in it than had formerly been given. In their person, mankind honors science; and they therefore endure in the general recollection as memorial stones of human progress after the waves of oblivion have long surged over the names of the makers of the most meritorious single investigations. Let us not delude ourselves. The only member of the Physico-mathematical Section of the Academy to whom a public monument has been erected, Alexander von Humboldt, owes that distinction not to the professional efforts by which his memory is kept alive in these halls, but to the grand recollections which his eloquent pictures of nature, the inspiration toward the true and the good that radiated from him, and his incomparable world-survey, have heaped around his name.

A second member of the Physico-mathematical class is shortly to be commemorated by a monument in one of the public places of our city—a man who, while his fame can not be measured with that of Humboldt, is comparable with that eminent prototype in the universality of his mental interests, the diversity of his work, and the place which he occupied as between two nations—our ADELBERT VON CHAMISSO. It is not, however, as a naturalist and traveler that Chamisso is to receive a monument, but for his other talents and excellences. We, his successors in this body, can not, however, refrain from recollecting on this occasion the side by

* Address delivered in the Berlin Academy of Sciences on the anniversary of Leibnitz's birthday, June 28, 1888.

which he is related to us, although too early taken away; he only belonged to us for three years. Proposed by Alexander von Humboldt and Kunth, he became a member of the Academy in 1835; and then was removed by death, at the age of fifty-seven years, on the 31st of August, 1838, the fiftieth return of which day is to be celebrated by the dedication of his monument. Unfortunately, we can find only the dates concerning Chamisso's election in the archives of the Academy. Still more strangely, our publications contain no scientific communications from him except a paper on the Hawaiian language, which was read in the general meeting of January 12, 1837, in which he describes himself as an old, sick, and weary man. Yet he was able to look back on twenty years of busy work, during which he left distinct marks on several branches of science; and it seems fitting to me to remind the present generation of some of them.

In what ways and through what vicissitudes the French emigrant's son, Chamisso, rose and became a German poet and the associate of the literary lights of his time is told in his friend Hitzig's biography of him. The energy with which he pursued literary art, when applied to the study of nature, laid the foundation of a scientific career in which he became the academical associate of Humboldt, Von Buch, Ehrenberg, and Johannes Müller; and it is our purpose to enlarge upon this side of his life.

Chamisso's military career ended when in 1806 he went to France as a prisoner of war in consequence of Hanelin's violation of his parole. He formed connections there by the influence of which he received a call after he had returned to Berlin to become a Professor of Greek and Latin in the lyceum about to be established at Napoleonville in La Vendée. The call proved an illusory one, but on his second residence in France he was drawn into Madame de Staël's circle, and received instruction in botany from her son, August de Staël. The name of the species *Staëlia*, Cham., in the order of the *Rubiaceæ*, commemorates the excursions of this pair among the rich flora of the Lake of Geneva and at the foot of Mont Blanc.

That this employment was suited to him will be evident when we recollect how, when he was still a boy at Schloss Boncourt, he "discovered insects, found new plants, and spent stormy nights looking and meditating at his open window, and that all his plays, his doings and undoings, tended to physical experiments and the investigation of the laws of nature." It is, therefore, not strange that he should have devoted himself with decisive earnestness to his new calling. He returned to Berlin, and was matriculated in his thirty-first year as a student of medicine in the newly established university. He studied anatomy under the elder Knape; and was not dismayed either by the dry lessons about bones which

the students facetiously called Knape's osteology, or by the unattractive condition of the dissecting art at that time. Thus he went, with a correct instinct, late but thoroughly, through anthropotomy, the true elementary school of biology. He worked in the Zoölogical Museum of Lichtenstein, helped arrange the fishes and crustaceans, and certainly heard Rudolphi on comparative anatomy and physiology, Weiss on mineralogy, which was very attractive to him, Erman on electricity and magnetism, and Horkel on natural philosophy. We are astonished at what he must have assimilated to himself during those three years in preparation for his journey round the world, when we find how well qualified he proved to be for every kind of observation on land and water.

While Chamisso's poems of the time of the war of deliverance contain nothing of importance, the period was marked by his most famous work, and one that has been translated into most of the languages of civilization—The Wonderful History of Peter Schlemil. In Schlemil, in his outer guise, Chamisso presented a prototype in many respects of himself; and in the way that Schlemil comforted himself for the loss of his shadow in striding over the earth with his seven-league boots, "scaling its heights, testing the temperatures of its fountains and of the air, observing its animals and studying its plants, speeding from the equator to the pole, and from one hemisphere to the other, and comparing experiences"—this fiction is only a reflection of the longings by which he was possessed, when, a French-German, or a German-Frenchman, there was no place, no sword for him in the combat. Out of the human tangle into the expanse of nature, the deeps of science, was his solution of the difficulty. Sharp questions have been asked concerning the meaning of Schlemil's loss of his shadow; it is symbolical of Chamisso's loss of a country. The dream described by Chamisso in "Schlemil" was soon to be fulfilled, but not by means of seven-league boots. He was not permitted to join the expedition of Prince Max von Wied-Neuwied to Brazil, but Hitzig showed him a newspaper containing an account of a contemplated exploring expedition of the Russians. A ship fitted up by Count Romanzoff was to be dispatched to the south seas, and was also to seek for a northeast passage from the Pacific to the Atlantic Ocean. Napoleon's return from Elba had just astonished the Congress of Vienna, and set Europe into a fright. In the newly blazing war-fever, in which he would have to remain an idle spectator, Chamisso's dissatisfaction rose to the highest pitch, and, stamping with his feet, he exclaimed, "I wish I was at the north pole with those Russians!" The sagacious Hitzig managed the affair with Russia; and Chamisso, recommended by Lichtenstein and other teachers, was appointed naturalist of the expedition, and reported himself on the 9th of August, 1815, to

Lieutenant Otto von Kotzebue, commander, on board the Rurik, in the roads of Copenhagen.

A happily decisive turning-point in Chamisso's career was reached with this event. In these days of steamboats and railroads, and journeys around the world in eighty days, we can hardly conceive of the importance that was then attached to a voyage like that of the Rurik, and how it would give definite direction and working material to the traveler for his lifetime. Ehrenberg, whose discoveries in the region of the minutest life quite eclipsed his voyages, was a single exception to this rule. The whole of Chamisso's subsequent scientific work may be regarded as the carrying out of what he began on this voyage. It lasted three years, and led from Plymouth to Teneriffe, Brazil, and around Cape Horn to Chili; to Salas y Gomez, past the island world of the south seas, to the Radak chain of the Marshall Islands; thence northward to Kamtchatka through Bering Strait into the Frozen Sea and back to the Aleutian island of Unalaska, where preparations were made for the polar voyage in the following summer. In the mean time the expedition went south again to California, the Sandwich Islands, and Radak; thence northward again to Unalaska, whence the attempt was made to penetrate the ice. At this point the original and real object of the voyage had to be given up. Kotzebue Sound, Eschscholtz Bay, and the Chamisso Islands are reminders within the Arctic Circle of this abortive enterprise, of which the voyage around the world was the only part realized. On the return the Rurik visited the Sandwich Islands for the second and Radak for the third time; then sailed by Guajan, one of the Marianne Islands, to Manila, around the Cape of Good Hope, and past St. Helena, to Europe. In London Chamisso met Cuvier and Sir Joseph Banks, the companion of Cook on his first voyage. On the 3d of August, 1818, the Rurik anchored in the Neva opposite Count Romanzoff's house in St. Petersburg. The expedition was broken up, and Chamisso was left in possession of what he had collected. He declined the invitation to remain in Russia, and returned to Berlin.

Chamisso crossed the line four times during this voyage, approached both poles, and made himself at home in the wastes where the ice rises to mountains, in the rude *yurts* of the tawny fish-eaters of the icy sea, as well as in the palm-crowned splendors of the tropics and among the airy huts of the graceful lotus-eaters of the south seas. Including Europe, he set his foot on the four quarters of the earth, and by a most remarkable coincidence went over Schlemil's journey; and just as Schlemil's boots could not take him over the wide intervening waters to Australia, Kotzebue would not venture to take his cranky vessel through the

dangerous Torres Strait, and Chamisso missed seeing the fifth quarter.

Chamisso's voyage was very similar in its general outline with the fruitful one that Darwin made fifteen years later. Darwin was also naturalist on a little war-vessel dispatched on hydrographic work, and the course of the Beagle covered that of the Rurik in many points, except that it visited Australia instead of the arctic regions, and Tahiti instead of the Sandwich Islands. Darwin, according to his Autobiography, does not seem to have been better prepared for his journey than Chamisso. He had never dissected, and could not draw like Chamisso. In one point he was better situated than our traveler: Captain Fitz-Roy furthered his ends, while Chamisso's captain gave him as little attention as possible as a naturalist, and treated him hardly better as a man. His collections were generally thrown overboard, and he had to black his own boots. The Rurik having only three quarters the capacity of the Beagle, the limitations of space were extremely adverse to collecting and observing. So much the more creditable is it to Chamisso that he was able under so many difficulties to conceal and bring home natural treasures of every kind, as well as to make copious fine and striking observations in every conceivable field. He has in this way enriched, first, botany, then zoölogy and natural history, geography of animals and plants, anthropology and folk-lore, geology and geographical physics with facts of greater or less importance. In two points his observations stretched over a wider circle than Darwin's—in that they extended to the polar regions, and that he, paying more attention to anthropology and ethnography than Darwin, studied the languages with which he came in contact. The discomforts of Chamisso's situation on the Rurik were alleviated by the society of two men who shared his scientific tastes. The Russian painter, Login Choris, was ready with his pencil to fix any remarkable features of the landscape or in natural history; and the ship's surgeon, Dr. Friedrich Eschscholtz, of Dorpat, was often an active, expert participant in his efforts.

Like Darwin, in his Journal of Researches, Chamisso, in his Voyage round the World, published his experiences, pleasantly interwoven with scientific observations, upon which a series of "remarks and views," in the third volume of Kotzebue's narrative, afford a commentary. Chamisso's narrative, rich as it is in pleasant details, lacks something that lends a high charm to Darwin's—the thread of a general thought, which we may possibly see more plainly drawn across his journal than he was perhaps conscious of at the time.

Our present effort to distinguish Chamisso's more important achievements is made difficult by his having permitted his energy

to be largely absorbed in details. It must first be recollected that he regarded himself as a systematic botanist. Shortly after his return to Berlin he received a position as assistant in the Botanical Institute—at first in the Botanical Garden, and afterward in the Herbarium—and filled that office till his death. He also, at the suggestion of Minister von Altenstein, composed a little botanical text-book for the use of schools, in the introduction to which he laid down his general views on organization and systematics. A memorial of his botanical work was published shortly after his death by his friend and former colleague von Schlechtendahl, in Linnæa, in which, under the running title *De plantis in expeditione Romanzofiana observatis* (On the Plants observed in the Romanzoff Expedition), several of Chamisso's plants were familiarly described. A modest plant of the family of the unwilting amaranths (*Chamissoa*, Kunth) preserves his name in systematic botany. His favorite plants were those of the water, particularly the *Potamogetæ*.

Chamisso's discoveries on the voyage began when he descried, even on the English coast at Plymouth, a species (*Centaurea nigrescens*) which had escaped the local botanists. In several places, as at Teneriffe and in Brazil, he was prevented from making important collections by the rainy season, and in Chili by the burning summer heat; but he obtained nearly the whole of the flora of the Radak chain, and the coast of California, which had been rarely visited by botanists, afforded much that was new; among others, the papaver called after his fellow-voyager *Eschscholtzia californica*, the seeds of which he brought home with him, and the brilliant flowers of which still adorn our gardens. The islands of the Arctic Ocean, between America and Asia, furnished a rich spoil in their Alpine flora, which strongly reminded him of the Alpine meadows of Switzerland. So sharp and skilled had his vision become, which he had begun to train to the observation of natural objects three years before his journey, that, botanizing on Table Mountain at the Cape of Good Hope with Mundt, of Berlin, who was sojourning there, he found, as at Plymouth, several plants that had until then escaped notice.

Schlechtendahl can not sufficiently praise the magnanimous unselfishness with which Chamisso, after his return home, surrendered his specimens to be examined by other botanists who seemed better fitted by their studies to that work. Thus, he sent to the Swedish algologue, Agardh, a collection of algæ, among which was a rare double form found at the Cape, a living fucoid (*F. confervicola* or *Sphærococcus*) on a conferva (*C. mirabilis* or *hospita*). Agardh, who was a little too earnest a transformist, and believed that certain algæ could become animals, imagined that in this case the one form was changed into the other—a view which, true

to his well-matured principles, Chamisso contested in a special memoir.*

As a reward for his earnest exertions, and also as a warning against too narrowly limiting the circle of possibilities in organic nature, Chamisso himself was destined to make one of the most remarkable discoveries in the region of metamorphism. This was in the case of the *Salpæ*, those soft, transparent organisms which, clinging to one another, swim over the sea in chains of from twenty to forty members. Besides the chains there are individual salpæ, but of two kinds, one of which bear traces in their organs of adherence of having been members of a chain, while the others do not. During a calm, on the voyage from Plymouth to Teneriffe, Chamisso made the surprising observation that the individual salpæ which have never belonged to a chain bear a progeny resembling the chain salpæ; while he found in the members of a chain young of forms agreeing with those of the single salpa. The salpæ of the chain, which produce single salpæ, are hermaphrodite; the single salpæ are asexual, and the chains are developed in them without fertilization, by inner budding. They thus alternate every two generations, one of which is sexual, and the other asexual and propagating itself by budding; and they are distinguished by other marks. To use Chamisso's figure, a salpa does not resemble its mother or its daughter, but its grandmother, its sisters, and its aunts. Chamisso called this kind of propagation that by alternating generations. So new and unprecedented was this discovery that, although Chamisso related it after his return in 1819, in a special Latin publication,† it either passed unheeded, or was stamped upon. But there came to Copenhagen, in 1842, a defender and champion of Chamisso's fame in J. Steenstrup, who discovered that the process of propagation by alternating generations such as Chamisso described was common to a series of organisms, including the *Medusæ* and *Strobilæ*, the *Cercariæ* and *Distomæ*, and the aphides or plant-lice, to which many others have since been added; so that the whole matter was cleared up in a trice. Johannes Müller's famous discoveries concerning the development of the echinoderms furnish a transition between the phenomena of alternation and those of metamorphosis as illustrated in the frogs and butterflies. The honor of having led the way to these discoveries belongs, as Steenstrup has expressly declared, to the accurate and ingenious investigator Chamisso.‡

* Ein Zweifel und Zwei Algen (One Doubt and Two Sea-weeds), 1829.

† De animalibus quibusdam e classe vermium Linnæana in circumnavigatione terræ . . . observatis, etc. (On Certain Animals of the Linnæan Class of Worms observed in the Circumnavigation of the Earth.) Fasc. 1, De Salpa. Berlin, 1819.

‡ Steenstrup on Alternating Generations. Copenhagen, 1842.

Another important subject, with the discussion of which Chamisso was associated, likewise relates to the pelagic fauna, but also belongs as much to geology and physical geography as to biology. It is that of the origin of the co-called sunken islands or atolls of the south seas and the Indian Ocean. It has been recognized from the first that these islands are the work of organic architects, the coral polyps, which absorb lime from the sea-water and build their oceanic castles with it.

After Johann Reinhold's theory that the ring-walls were built by the polyps from the depths of the ocean, and Henrik Steffens's hypothesis of submarine craters, came Darwin's celebrated theory, which supposed that the corals were built upon a substructure already existing in the ocean-bottom which gradually subsided under a continuous volcanic action so as to keep the rising structure at about the same level; and after that the contradiction of it by Murray and Wyville Thomson, on the basis of observations made during the Challenger Expedition, which pointed to a rise of the substructure. Here comes in a fundamental observation with which Chamisso's name has been associated, to the effect that the coral animals, never moving away from the one spot to which they attach themselves, need a stirring sea to bring them food, oxygen, and lime. Hence an atoll will rise wherever there is a suitable foundation, at not too great depth, on which the polyps can fix themselves; and as they thrive better on the edge of their ring, where they are favored by wave-beats and currents than in the middle, a ring-wall will rise, which should be higher, as is the case, on the windward side, where the wave-motion is strongest. These facts have been put prominently forward in all the discussions that have been had on the subject; and Chamisso has been credited with having been the first person who observed and mentioned them. I am obliged to disclaim Chamisso's title to this honor. The observation was first ascribed to Chamisso by Darwin, who says, in his Coral Reefs, "The larger kinds of corals, 'which form rocks measuring several fathoms in thickness,' prefer, according to Chamisso, the most violent surfs"; and from Darwin's it has passed into other works. A study of Chamisso's writings will show that, while he acccurately examined and described the atolls petrographically, geognostically, and zoölogically, he never made that remark. Darwin's mistake originated in his attributing to Chamisso a remark which appears at the end of the third volume of Kotzebue's First Voyage (containing also Chamisso's Remarks and Observations), in an Appendix from other Authors, which, there is abundant evidence to show, was made not by him but by Eschscholtz.

"The coral reefs and islands of the great ocean," says Chamisso in Ansichten von der Pflanzenkunde und dem Pflanzenreiche,

"are as much products of animal life as the peat-bogs are products of vegetable life." We get an idea of the comprehensiveness of his view of Nature when we consider the attention he gave, soon after his return from the voyage around the world, to so comparatively insignificant objects as the North German peat-bogs. The opinion, based upon an observation of Alexander von Humboldt, then prevailed, and was held by Leopold von Buch, that such bogs as that of Linum, near Berlin, contained remains of a sea-weed (*Fucus saccharinus*), and were, therefore, to be regarded as of marine origin. After an examination, which he began at Linum with Poggendorff and Friedrich Hoffmann, and continued alone at Rügen and along the Baltic coast, Chamisso supplied the proof that the sea had had no part, either in the interior or on the coast, in the formation of peat, and that no change in the relative level of land and water need be supposed to explain the process. Chamisso saw again at the peat-bog of Linum the *Kimming*, or mirage, which had prominently exhibited itself to him in the high north. He attached to this observation a less known remark, which I recollect having heard in Paul Erman's Lectures, that the mirage can be seen in vertical planes on long, straight, sunny walls, like the old city wall of Berlin between the Potsdam and Halle Gates.

Chamisso's zoölogical observations were by no means limited to the lower forms. He regarded the vertebrates of all latitudes with equally earnest attention—the flying-fish; the birds that rested on the Rurik; the whales, which he dreamed of taming and training to service; and the sea-lions, through a bellowing herd of which he walked fearlessly on St. George's Island. He made profound psychological observations on the monkeys that were taken on the Rurik. He also had an eye for extinct animals. A tusk which was dug up at Kotzebue Sound was referred by Cuvier in the *Ossements fossils*, on the evidence of his drawing and description, to the mammoth.

But, as we have already observed, Chamisso gave special attention on his voyage to the study of man himself. Of course, exact observations and determinations of the physical constitution of men coming up to present ideas on the subject were not to be expected from him, although he collected skulls; and he must have been overtaken many times in details by the growth of commerce in the last seventy years, and the more perfected methods of research, like anthropometry, plaster-molding, and photography. But he still stands the author who, through his distinction between the two chief provinces of the great ocean and a separate group of islands, first cast light on the mixture of peoples who dwell in the island world. Thus, according to Bastian, the distinction of Micronesia from Polynesia was first indicated by

him, and, in the north, he furnished valuable data concerning the relationship of the Asiatic Chuckches and the American Eskimos.

The general result of his studies of history and nature, as he expresses it, is again opposed to the views now prevailing, in that he regarded man as very young on this old earth. But, although his anthropological views seem to be in many respects antiquated, his ethnographical sketches are of exceeding value in that he has lovingly and carefully given us a vivid and picturesque view of human conditions on the oceanic islands that can never be surpassed, for the simple reason that the original is irrecoverably lost. With prophetic view Chamisso predicted the annihilation of this endlessly charming culture by contact with the dreadful white man—a prediction which has been already to a large extent fulfilled. He knew well what he was doing when he described, drew, and made memorable what he could of customs and usages, religious ideas and superstitions, myths and songs, costumes and weapons, vessels and sea-tackle. And after his return he repeated, impressively and loudly, the advice that the threatened treasures that still remained should be saved at once. The poet is recognized in the pretty parable in which he clothed his lamentation: "All the keys to one of the most important problems which the history of the human race in its wanderings over the earth presents to us are being thrown by ourselves into the sea of oblivion at the very hour when they are given into our hands." Only in very recent times, when it has become almost too late, have we begun to move in the direction pointed out by his admonition.

Perhaps Chamisso was influenced by some of Rousseau's ideas in his extravagant admiration of the handsome, happy, easy-going men of the south sea islands, particularly of the Radak chain. He had not words enough to praise the native nobility of the men and the chaste grace of the songful women of Radak. He bitterly condemned the silly arrogance of the sham civilization that called these men savage. He contracted what by the taste of these days would be regarded as a somewhat sentimental friendship with an especially intelligent man, a castaway on one of the Radak Islands, who trusted himself upon the Rurik to be taken to his home on one of the Caroline Islands. Kadu, as he was called, who, however, left the ship when it touched the Radak Islands for the last time, plays an important part in Chamisso's reports, because he was able to give him information not too easily obtained otherwise on a number of questions, and Chamisso laments that he was deprived by the separation of the opportunity of being further instructed by him. Kadu rendered inestimable service in the linguistic researches which Chamisso pursued with extraordinary zeal and industry. Chamisso had a gift for languages, although

he could not learn Russian, which he displayed in the ease with which he could come to an understanding with the men of different tribes who came on board the Rurik. His Bemerkungen und Ansichten contain full vocabularies of three Polynesian dialects, among them that of the Radak chain, and proofs of the Radak folk-poems, in which he found a solution of his own for the problem of phonetic transcription, which has been so much discussed since his time. He continued these studies at Luzon, where the Tagalic language (of the Malaysian group) had been reduced to writing, and collected a Tagalic library, which he held as one of his most valuable acquisitions. When his house at New Schöneberg was burned in 1822, after the lives of his family, this Tagalic library was the first thing he tried to save, and, to preserve it from future dangers of the kind, he presented it to the Royal Library. In unison with a conviction of the unity of the human race, he also in philology believed in a single origin for all languages, in striking contrast, as Max Müller has remarked to me in a letter, with his habit of emphasizing the specific in natural history.

A linguistic episode which Chamisso relates is, perhaps, even now of some current interest. The curious custom was in vogue in Tahiti of (on the accession of a new ruler and similar cases) extirpating words from the common (not the old liturgical) speech and replacing them with new ones. About the year 1800, Tameiameia, the King of the Sandwich Islands, likewise, on the birth of a son, invented an entirely new language, and began to introduce it. The newly formed words were not related to any roots in the current language, and even the particles were changed. It is said that some of the powerful chiefs, displeased with the movement, poisoned the child who was the occasion of it, and what had been undertaken on his birth was given up on his death. The old language was restored and the new one forgotten, so that Chamisso only found a few fragments of it. He learned just enough of the Hawaiian language to enable him to speak intelligibly with the natives concerning the most necessary matters, but made no attempt to commit it to writing. When he came to revise his Travels for a new edition, just before he was elected to the Academy, the Hawaiian language had become one of literature, and the murder of a prince was not needed to deliver it from an artificial rival. Publications enough had issued from the Hawaiian press to make a fundamental study of the language practicable. Wilhelm von Humboldt had begun, in the course of his great work on the Kawi language of Java, to cast light upon the Polynesian languages, when death called him away on the same day that Chamisso's election came up. The latter now thought he recognized a calling derived from his voyage and his

earlier studies to devote his later efforts to making this field of linguistic research cultivable. He undertook to learn the Hawaiian language from the books which he had at hand, and assigned himself the task of preparing a grammar and dictionary of it.

We have thus gone around the circle of Chamisso's scientific work. From a profusion of single observations, remarks, and experiments only a small part of his peculiar activity can be illustrated here. Considering his activity as a whole, it must be conceded that his strength did not lie in the direction of strict theoretical analysis. This is not to be wondered at if we consider the condition of theoretical science in Germany at the time, when it was just beginning to recover from its enervating entanglement with philosophy. But the characteristic and really remarkable feature of Chamisso's scientific activity is his power of embracing the whole world of phenomena with the same love, freshness, and elasticity—from the stone that rung under his geological hammer; the hay, as he modestly named his dried favorites; the seaworm, which revealed to him one of its most wonderful mysteries; to that noblest production of Nature, as man represents himself to objective research, whether considered as a single being related to the animals, as a tool-making, fire-using, social creature, or, in his highest expression of speech. With sound, lively sense, with always ready energy, Chamisso stands before the things of Nature, exercises unreservedly every kind of observation, and forms his conceptions without prepossession and with strict limitation to the actually known. He was thus, although his monographs may have been overtaken or his general views have fallen behind those of the present day, a complete naturalist in the best sense of the word, and that at a time when such men had to be looked for through Germany as with a candle.

Many of those who go by his marble image in the future will recall "Peter Schlemil," "Schloss Boncourt," and Salas y Gomez. A few will think of the botanist and ethnologist Chamisso, of the salpæ and the coral islands. Greeting from their inmost hearts the few will bow to him who like him, in an iron age, and in the midst of the striving after the real, have kept in disposition, fancy, and spirit a place for all that is of man, for the ideal, and the beautiful.—*Translated for The Popular Science Monthly from the Deutsche Rundschau.*

CORRESPONDENCE.

THE INFLUENCE OF SPENCER'S PHILOSOPHY.

[TRANSLATION.]

Editor Popular Science Monthly:

SIR: Being a diligent reader of the review which you direct, and which I consider one of the best exponents of scientific progress, and spending a short time in this city, I have read with satisfaction in the number for August the article entitled Mr. Spencer's Place in Philosophy. Only ignorance of the influence which the scientific philosophy of Mr. Spencer is exercising in the modern world, and of the place which philosophy in general occupies in the order of human knowledge, could have permitted the editor of the New York Times to question the position which the superior intelligence of the English philosopher has conquered.

While I do not know what the respondents of the writer who calls himself "Outsider" have brought forward, and while I have no books at hand and can only follow the tone of your reply, I hope I may be permitted to indicate a few of the points in which specialists in different sciences have been anticipated by Mr. Spencer.

When he wrote his Principles of Biology, organic chemistry was in its infancy: Gerhart had not yet occupied himself with the serial classification; Kekulé had not yet discussed the molecular constitution of the carbon compounds; and the mind of the philosopher was still only occupied with the application of mechanical principles. Nevertheless he was able to anticipate the true function of organic carbon and the peculiar chemical properties of nitrogen. Many chemists were not agreed respecting the importance to be ascribed to nitrogen in vital reactions. But the inertness of that body; its strange manner of entering into combination; the inverse reactions which it provokes; the variations of its equilibrium with the proportions in which it forms part of compounds; the different modes of its behavior under the influence of electricity; the personality, as we might say, which it possesses in every reaction; and, especially, the difficulties which chemists like Schoenbein, Deville, Munst, Marcam, and Berthelot have met in accounting for the method of its entering into combinations to form vegetable substances, now proceeding from the air and now from fertilizers—all these features Mr. Spencer's paper assigned to this body and illustrated before chemical studies demonstrated them. We will not concern ourselves with the later spectroscopic observations, nor with the discussions, of which the two very different spectral systems that nitrogen presents have been the occasion, for they are not in question here.

Until a recent date, chemists held to a conception of the atom not widely different from that which was accepted in the time of Epicurus, and his atoms were identical with those which Dalton conceived. But Mr. Spencer, before William Crookes had resolved yttrium into its more simple components, before he conceived the idea of protyle, had spoken of the *physical atoms that constitute the chemical atom.*

If he who calls himself "Outsider" had read a letter of Mr. Spencer's addressed to the North American Review, which was inserted at the end of the first volume of the French edition of the Principles of Biology, in which he declared himself against the theory of spontaneous generation, not only as it then existed among students, but also as Haeckel afterward defined it in his theory of perigenesis of the plastidules, he would have been convinced that the philosopher had anticipated the results obtained by the latest biological studies and the conceptions of the chemists of to-day on the complexity of organic molecules.

Mr. Darwin introduced an epoch in the history of thought. But, before the Origin of Species appeared, Mr. Spencer had formulated the doctrine of transformism in a manner so universal that the truths demonstrated by Mr. Darwin are seen to be a necessary consequence of the laws of evolution.

The opinions of the philosopher on the constitution and mechanical function of the nervous system, as well as respecting the office which is filled by the system of the great sympathetic in the higher animals, occupy a distinguished place in modern physiology.

In the subjective analysis of thought, Mr. Spencer has reached a point that no one had attained till his time; and his incontrovertible criticism of the concepts of Kant, and of the ideas of time and space, reveals a profundity of intelligence which was not surpassed in Aristotle.

His social studies are instructive to the statesmen of the present. His criticisms of the parliamentary systems of Europe have modified the ideas of political men. The recrudescence of the military *régime*, with all its consequences, was foreseen by Mr. Spencer; the exposure of the absurdities of much modern law making by constituted states is his work; no one has demonstrated as he has done the wonderful power of individual initiative as opposed to the Attila's horse of state intervention; the

force of German socialism as a consequence of the socialism of the state imposed by Herr Bismarck was foreseen and censured by the philosopher. The New Toryism and the Coming Slavery which he foresaw, already exist in Europe. The pernicious consequences of protectionism, which have occasioned great commercial crises in the old continent, but which the United States have escaped suffering only because the economical errors of the system are in great part balanced by the magnificent political organization they possess and the conditions of the environment and the ethnical relations that help you, were all pointed out in the sociological works of the philosopher. What authority can be seriously opposed in this day to the arguments of the socialistic party in its contentions against the present organization of society, except we invoke the sociological principles established by Herbert Spencer?

It remains, in concluding this letter, to point to a fact which relates particularly to my country, Spain. Before the doctrines of the philosopher had spread among the Spanish thinkers, radical partisans had no faith except in the processes of the French Revolution and in the Declaration of Rights written in the Constitution, the precepts of which, however, were not complied with in practice. But to-day, the radical Prof. Salmeron, as well as the conservative D. Antonio Canovas del Castillo, invoke only the principles of the laws of evolution. In no other principle has been founded the changed course of conduct pursued by the eminent tribune, Don Emilio Castelar, during the last fifteen years. I remain your obedient servant,

GASTON A. CUADRADOS,
Pharmacist-major in the
Spanish Army in Cuba.

NEW YORK, *July*, 1890.

A DEFENSE OF MECHANICAL TEACHING.

Editor Popular Science Monthly:

DEAR SIR: In the November Popular Science Monthly I notice a letter from Anna Chapin Ray in which some educational methods, so called, are severely criticised. While I acknowledge a certain justice in the criticism upon the particular points cited, I beg leave to suggest that possibly a closer observation of school work might show reasons for the line of action indicated in the different instances. To designate pupils by numbers instead of by their names does seem mechanical, to say the least; but when we remember that a teacher has perhaps eighty children, with a recitation period of not more than thirty or forty minutes, and when we also remember that it takes less time to count eighty than it does to pronounce eighty names, we can hardly wonder that the teacher resorts to that means which will secure her the most time for actual class work. The teacher is not responsible for being driven to this. School boards are responsible, and we should understand that it is impossible for any teacher to do natural educational work under such conditions.

I have not yet considered the subject of writing to the accompaniment of music sufficiently to give a decided opinion upon this question, but I think I can see that music may be a means of obtaining certain desirable ends in this connection. It may be the means of securing regularity, precision, uniformity, and rapidity of action, and so may be of value. It does not follow that, if music is used as a means in teaching writing, those pupils who may become accountants should do their work to the accompaniment of music. The music is only a means to an end, which in this case is skill in writing. If by means of music this end be attained with a less outlay of time and energy than it could otherwise be secured, it seems to me that the teacher shows wisdom in using it. As soon as the end is gained, the means, of course, can and will be dispensed with. Whether the use of music here be judicious or not, I think that no one will question the importance of securing uniformity of action upon the part of pupils. In a writing-lesson, as in other lessons, it is well that the pupils all observe a direction at the same time. If every child were allowed the privilege of being a few moments behind every other, your correspondent can see that very little work would really be done. Concerted action on the part of children is desirable; by means of it the more impetuous pupils of the class are restrained, while slower ones are brought forward more rapidly than they otherwise would advance.

Class interest, and indeed all social interest, is based either directly or indirectly upon concerted action. It does not render the pupil less capable of acting alone when occasion requires, and it does enable him to adapt his actions to those of another person when such adaptation is necessary, as we find it to be more or less in all the relations of life.

In regard to the book work, I can also understand that a teacher might very wisely take means to prevent the children from anticipating the work on hand. If original work on the part of the pupil were required, it would be well that he should not make use of the matter contained in his book, as the end in view would certainly thereby be defeated.

Again, I should like to suggest that the line of action pursued by the different teachers in the different instances stated can not possibly be considered as "methods" of instruction; they are at best but crude plans employed by the teachers for the purpose of securing certain ends. Method in instruction implies the uniform observation of educational principles; while those plans mentioned very often illustrate in the teachers an excess of that individuality which your correspondent claims for the pupils. If the

child is to be individual in his actions, the teacher should certainly be so. The fault in the instruction in our public schools at present, however, is not a lack of individuality, but rather a lack of uniformity. If our teachers depended a little less upon their own individual impulses, and more upon the recognized principles of education, we should probably have fewer imperfect plans to criticise, and would secure better results in our work.

We have not to complain of a "craze" for carrying methods to extremes so much as a "craze" for individual prominence, which results in somewhat absurd plans of procedure that must be abandoned as soon as their novelty wears away. Nothing will correct this weakness so completely as the uniform training of teachers in accordance with recognized psychological principles. When this is secured, the observers of school work will at least do teachers the justice to suppose that they have excellent reasons for what may appear to the uninitiated to be mere erratic action. Yours truly,

MARGARET K. SMITH.

OSWEGO, N. Y., *October* 24, 1890.

UNNATURAL READING.

Editor Popular Science Monthly:

SIR: In your issue of November appears a letter from A. C. Ray, calling attention to the method of teaching reading in vogue in our public schools. To quote the writer's own language, "Children are taught to read without spelling, recognizing each word by its appearance, and learning it as a detached fact."

Your correspondent then goes on to show the unnaturalness of the "natural method" so called. Permit me to say that I personally thank the writer for having had the courage to bring this matter to the attention of your readers. The present natural method of teaching children to read is indeed an absurdity, and it is difficult to understand the reason and the authority upon which such a system has been adopted.

My little girl is attending a grammar school in Cambridge, Mass., which has the reputation of being a very good one. My child is in the fifth class, and I am informed by the teacher that this class offers greater difficulties to the average pupil than any of the higher classes. Night after night I have the pleasure of rehearsing with her the writing-lesson of the day. Now, how does the child learn to read! The school uses Swinton's History and Geography. From this book the teacher, no doubt acting under instructions, reads daily with the children, and then dictates to them the principal words contained in the paragraphs they have been reading. I beg to be understood that the words are dictated and written by the children *as they are found* in the text-book—i. e., the verbs not in the infinitive mood, but in any of the several tenses; nouns either in the singular or plural; all in confusion. I will give here a few of the words found in one of the lessons: Sachem, aurora borealis, Cheyenne City, arctic, eider-down, Phœnix, Indianapolis, Indian dialect, Latin language, French or Indian, Greek language, German language, Latin language, compound English-Greek.

It will be observed that these words represent a fine collection taken from several old as well as modern languages. No explanation is given by the teacher concerning the derivation of the words; if she thinks well of it, she will tell the children what the meaning of such a word is, but all the rest is a *tabula rasa* to the pupils.

No doubt some people will not believe me when I assert that, though my child has been attending school four years, has been studying writing and reading for the same time, she has never been taught the difference between a vowel and a consonant, and, consequently, she is ignorant of the very tools she is called upon to work with.

It seems but too simple a thing to call attention to the numerous recurring unchangeable prefixes, affixes, endings, etc.; such, for instance, as "ious," "ive," "able," "ation," etc., or to tell them that a certain grouping of characters as a rule produces such and such sounds, all of which would materially assist the pupils and save them hours of laborious work. But no, let them grope in utter darkness and recognize each word by its appearance! If that is a correct way of teaching children reading, why don't you apply the same method to teaching arithmetic? As the English language contains about forty thousand words, independently of numerous derivatives, compounds, and grammatical formations, the idea of teaching children reading by recognizing each word by its appearance is indeed absurd.

The evil effects of such a system are self-evident, but the means of overcoming the evil are not so apparent, and after a good deal of consideration I have thought best to apply to The Popular Science Monthly for assistance. No doubt many fathers and mothers will take a deep interest in this matter touching the education of their offspring, and as it is useless for an individual to go to the several school boards, laying his or her grievances before them, I suggest that through the agency of The Popular Science Monthly an association may be formed of such people as are interested in the education of children; that the aim of such association be united action to bring sufficient pressure to bear upon the several school boards to modify or abolish the method now used in the public schools to teach children reading, and to consider ways and means to best accomplish this purpose.

I shall be glad to hear from other people in this matter. VICTOR M. BERTHOLD.

CAMBRIDGEPORT, MASS., *October* 27, 1890.

EDITOR'S TABLE.

A DOUBTFUL PROP OF MORALITY.

VERY persistent are the attacks of the supporters of an effete philosophy upon those intellectual views which are renewing the life of the world and enabling the human mind to shake off the burden of spiritual tyranny. Some of our readers may remember an article which we devoted a couple of years ago to a novel by a celebrated member of the French Academy, M. Octave Feuillet, the leading character in which was a young woman who had been brought up by a philosophical uncle in complete emancipation from theological beliefs, and who took, in the most natural way in the world—as the direct result, we are given to understand, of her acceptance of modern thought, and particularly of the Darwinian theory—to a career of monstrous and cold-blooded villainy. Her uncle was a benevolent old gentleman; but the evolution philosophy showed its perfect result in the niece, who had imbibed it in her very earliest years. This fine example of a "novel with a purpose" appeared first in the columns of the Revue des Deux Mondes; and to-day we find in the same periodical no less striking an example of a drama with a purpose, the author this time being M. George Duruy, and the title of his production Ni Dieu ni Maître. In this work the philosophical and philanthropical uncle of M. Feuillet's creation is replaced by a father—an eminent medical man—of similar views and similar character, who has brought up his own two children in complete independence of priestly control, and who, in return for all the affection he has lavished upon them, reaps a harvest of selfishness and ingratitude. Without being as utterly depraved as the delightful heroine of M. Feuillet's romance, they are mere creatures of pleasure and vanity, and when their poor father falls into ill-health and comparative poverty, instead of sympathizing with and aiding him, they have nothing for him but complaints and reproaches. The uncle in M. Feuillet's story and the father in M. Duruy's, it is noticeable, are both physicians, these authors paying the medical profession the compliment of thinking that the study and practice of medicine are particularly favorable to a philosophic cast of mind. M. Duruy throws in an interesting minor character in the person of a smart young physician, who had studied under the elder one, and who, in the days of the latter's prosperity, had become engaged to his daughter, but who, having got possession of the lucrative practice which the elder physician, through failing health, had been compelled to hand over to him, throws the daughter overboard without the slightest compunction. This young man, too, is offered to us as a shining example of what free-thought means when reduced to practice. Tricked out as these fictitious narratives are in all the graces of style that literary art can command, they are doubtless adapted to have an effect on a certain class of minds. Rich devotees of luxurious superstition will be greatly edified by the demonstration that not common sense but ecclesiastical authority is to determine all questions of education and conduct; and timorous souls in general will be glad to find that they are justified in refraining from any independent exercise of their minds upon moral questions. Others, among whom we count ourselves, find more of "purpose" than of honesty in these representations: to us they do not show the true working out either of the ancient or of the modern principles of morality, and we propose once more to show why.

One fact is incontrovertible, let liter-

ary or other reactionists say what they will, and that is, that in a moral point of view the world is vastly better to-day than it was centuries ago. The world has had its ages of faith; the world has now its age of comparative reason. If we want poisoners who could outdo the performances of M. Feuillet's young woman in La Morte, we go to the ages of faith, we seek them in papal courts amid cardinals and their relatives. If we want filial ingratitude in far more hideous forms than M. Duruy has undertaken to paint, the same society, in the same age, will furnish it. The true middle age is shown in the works it has produced, in the Decameron of Boccaccio and the Canterbury Tales of Chaucer, in which lust and superstition walk hand in hand. Charles Reade has also given a powerful picture of it in his acknowledged masterpiece, The Cloister and the Hearth. Let any one compare the condition of Europe at that time with its condition to-day, and then say whether the material, moral, and intellectual interests of mankind have not gained immensely by the emancipation of thought and the weakening of authority.

But if we look at the case presented to us by M. Duruy in Ni Dieu ni Maître, we shall see how very ill he conceives the duties of a really enlightened father toward his children. His Pierre Nogaret, a physician in the very front rank of his profession, with an annual income of over a hundred thousand francs, has two children, Maurice and Adrienne, whose mother is dead. Instead of interesting himself in their education, he turns them over to hired teachers, and never asks what progress they are making or how their characters are developing. In a conversation between the brother and sister, the former is made to say: "I have grown up I don't know how; no one has ever told me what is right or what is wrong, and I can't find it out entirely by myself. Papa made me take up the study of the sciences, but he never took the trouble to see whether I learned anything, and now there are moments when I feel that I am not worth a rush." The sister has very much the same account to give of her education; and both brother and sister were brought up, as the story shows, in very extravagant habits. Both were launched into the world of fashion without any effort being made to guard them against the temptations to which they were thus exposed.

Now why, we ask, should this be offered to us as an example of education upon modern principles? Why should a man, because he has embraced, let us say, evolutionary views, allow the education of his children to proceed at hap-hazard? Why should such a man leave his children unprotected against the seductions of a vitiated society? Why should he allow their home affections to be weakened and stunted by a senseless immersion in social gayeties? If a clever writer wishes to do justice to the great question which MM. Feuillet and Duruy approach in so partisan a spirit, let him draw a picture of a man who has discarded superstition because of its demonstrated falsity, who has embraced the principles and results of science because of their demonstrated truth, and whose aim it is to do in his lifetime the utmost amount of good that circumstances permit. Then let this man have in conjunction with these elevated views a certain amount of common sense. If he has children whom he sincerely loves—and such love is not an unreasonable postulate in a father—let him recognize that, if they are to dispense with the conventional aids to right conduct, they must have others in their place, and let him duly cultivate their moral and emotional nature. Let him refrain from placing them, or allowing them to be placed, in circumstances of too great temptation. Let him carefully guard against their becoming the slaves of luxury and idleness. Let him not give them as associates persons

whose principles of action are the very reverse of his own. Let him not betroth his daughter to an intriguing jackanapes who avows himself destitute of every principle save selfish ambition. Let his love for his children be manifested otherwise than by keeping up an expensive establishment. If these conditions be observed, we shall have a man who, point for point, shall do just what Pierre Nogaret *did not do*, and refrain from doing what Pierre Nogaret *did do*. And then let it be shown, if it can, in consonance with recognized principles of human nature, how such methods of training and discipline lead directly to ill-regulated and frivolous lives on the part of the philosopher's children. Let us see just how it comes about that natural affection dies out in the atmosphere of such a philosopher's household. Let us be made to feel in a powerful manner the chasm that is left in the philosopher's family life by the absence of the priestly element. It is easy to make men of straw and then knock them over or treat them with any other indignity; but the task is not one that is worthy of a literary artist of any ability. In M. Feuillet's romance there was some attempt made to show how the doctrine of the survival of the fittest naturally inspired thoughts of murder in the female mind. We did not think much of the proffered demonstration, but it made at least a decent show of respect for the requirements of logic. In M. Duruy's drama such show of respect is wholly lacking. His philosopher entirely neglects his children's moral education, brings them up in expensive, luxurious, and idle habits, exposes them to all the temptations of a morally worthless society, and then, when they have been—not wholly, but largely—perverted by the evil influences around them, we are asked to lay the whole blame of their perversion upon their father's heterodox views, and to draw a sweeping conclusion as to the ruinous effects on morality of modern philosophy in general.

The unprejudiced reader will not draw any such conclusion. The conclusion that may be drawn is that no set of merely speculative opinions offers any guarantee for satisfactory moral development apart from a careful observance of the conditions on which the formation of sound, moral character depends. It is one thing to adopt the Darwinian theory; it is quite another to know how to bring up children: and some Darwinians, or alleged Darwinians, make nearly as poor a business of it as some clergymen. It is not the mold in which a man's opinions have run that makes him a competent moral educator; it is the amount of earnestness he throws into moral questions and the amount of practical good sense that he brings to bear in order to insure that the children committed to his charge shall be well grounded in sound moral principles and habits. The son of M. Duruy's philosopher tells his sister that if ever he succeeds in capturing a woman with a big fortune and has children, she will see how he will "stuff them with religion." Alas! the recipe is not a new one. How many children have been "stuffed with religion," only to grow up exceptionally bad! The children who do best are the children of parents whose lives bear still more powerful testimony than their words to right principles, and who are not too busy to take a constant interest in their children's education, moral as well as intellectual. To ask the world to go back to mediævalism in order to save morals from destruction is asking too much. That system has been tried and found wanting, and the world is now seeking another and a better foundation for morals. Doubtless many rush forward and grasp at the new opinions without realizing all that they involve and demand. The age is one of unsettlement; but it is one, unmistakably, of progress; and when our methods of education have been adapted to the new truths now in course of formulation,

there will be no reason to regret the props and stays and leading-strings that helped to steady the morality of the past.

HUMAN SELECTION.

We published in our last number an interesting article under the above title, by Mr. Alfred Russel Wallace. Mr. Wallace is much concerned over the fact that modern society is being recruited chiefly from the ranks of its less worthy members, and is thus undergoing a constant process of deterioration. Under any form of government this would be a serious danger, but, where democratic institutions prevail, it forebodes, unless it can be arrested, nothing less than social dissolution. The more favored classes marry late, for the most part, if at all. Their children are comparatively few. The improvident and worthless marry early, without the least regard for consequences, and flood the community with their degenerate offspring. That is the situation as described by certain writers, and the remedies proposed are many and varied. One writer wants restrictions placed on marriage, whether of a physical or merely legal kind we are not sure. From the very careful manner in which Mr. Wallace touches upon this suggestion, we rather fancy that something radical in the way of surgery has been proposed. Another authority, who ought to be better advised, wishes to substitute a very high-toned system of concubinage for the present institution of marriage, so that the female sex may be able to select worthy sires for the children they are disposed to bear. Another would have premiums given to young couples of unexceptionable strain, physical, mental, and moral, so that they may start early in life to contribute good citizens to the commonwealth. Mr. Wallace does not look upon any of these plans with approval, and rightly pronounces the second "detestable." He thinks, for his own part, that we ought to have an economically reformed society *a little* after Mr. Bellamy's ideas, and that, if we had, the women might be trusted to take care of the future of the race.

If Mr. Bellamy had done more than dream a very incoherent dream, we might think that Mr. Wallace had struck into the right path. We believe in female selection as an influence destined to be very potent in the future, but we do not look to any such scheme as Mr. Bellamy's to bring it into play. It is being brought into play now through the growing independence and intelligence of women, and there is no doubt at all that, as women are more and more trained to practical usefulness, not only in the family but in the business world, they will consult both their own dignity and the interests of posterity more than they have hitherto done in their acceptance of the married state.

We are not disposed to consider the situation quite so serious as Mr. Wallace describes it; but doubtless there is some room for apprehension as to the future, and, if we might venture to make a suggestion in our turn, it would be that our troubles, such as they are, largely arise from over-legislation, leading to a hurtful decline in the sense of individual responsibility, and from altogether too weak methods of dealing with crime and pauperism. On the former point we have often dilated, and shall not do so further on the present occasion. On the latter point we may remark that nothing can possibly be more obvious than the necessity of isolating—permanently if necessary—the anti-social from the social members of society. In dealing with contagious diseases we carry out a rigorous system of isolation, and maintain it just as long as the danger of infection lasts. Criminals we imprison for a time, and then turn loose to prey anew upon society and beget offspring in their own depraved image. Paupers and various grades of helpless people we assist to support,

without imposing any check upon their reproductive activity. All this is very foolish. A man is either able to maintain himself or he is not. If he is not, and declares himself not to be by the systematic acceptance of alms, then society may reasonably declare that he is not fit to found or control a family, and he should henceforth be assisted under such conditions and restrictions as should at least prevent him from casting new burdens upon society. If we could stop our miserable political (so called) wranglings long enough to take a common-sense view of the situation and become really interested in plans for its amelioration, the difficulties would not be found at all insuperable. Fit for civil rights or unfit for civil rights?—that is the question to be applied to every member of the community. If we persist, through sheer indolence and love for all that is paltry in the rivalry of parties and the squabbles of public men, in according civil rights to those who do not merit them through an active co-operation in the industrial life of the community, there is serious trouble in store for us. We might as well voluntarily take diseased persons into our households as keep morally and economically diseased persons on the roll of our citizens. What the latter want is control and segregation at whatever momentary cost. We simply recommend a quarantine that society has the full right to exercise. It would be cheaper at once to give rations to these people than to allow them to subsist on occasional charity and occasional stealings, while seriously interfering with the hygienic condition of the community, to say nothing of perpetuating their kind. Just how they should be dealt with when separated, what work should be exacted in return for maintenance, what educational measures should be adopted—these are questions for later consideration. The "human selection" that is required is primarily a selection that will put aside those members of society who in moral character or in the power of self-help fall below the requirements of decent living. This can be carried out as soon as we have sense enough to attempt it; and when once such a separation has been effected, and we have no longer in the heart of society a perennial spring of baseness and incapacity, the march of improvement in all directions will be rapid; while year by year the burden thus assumed by the state will diminish.

ANNOUNCEMENT.

We have the pleasure of putting before our readers in this issue of the Monthly the first of a series of articles which will give a comprehensive view of the evolution of each of the great manufacturing industries in America since the time of Columbus. They will be written in the popular style which has always characterized the Monthly, avoiding mere technical details and wearisome columns of statistics. At the same time, the writers have had long acquaintance with the practical side of the industries which they describe, and this complete command of their subjects enables them to present just those features which the general reader demands. Mr. William F. Durfee, who opens the series with an article in the present number, is known to the iron and steel men all over the country as a man of wide experience in the building and operation of iron and steel works, and is at present General Manager of the Pennsylvania Diamond Drill and Manufacturing Company. Our history of the cotton manufacture will be furnished by Mr. Edward Atkinson, who needs no introduction to the readers of this magazine. Mr. S. N. D. North, Secretary of the National Association of Wool Manufacturers, is the author of our account of the woolen manufacture. The development of glass-making will be described by Prof. C.

Hanford Henderson, whose illustrated articles in the Monthly on the present methods of this industry have been widely read. Articles on the Silk, Paper, Pottery, Shoe and Leather, Agricultural Machinery, and Ship-building industries will be furnished by equally competent hands. In describing the methods and the implements and constructions used in manufacturing, a picture is often better than pages of words; accordingly, this series will be fully illustrated. For the account of the iron and steel industry alone, sixty-eight engravings have been prepared. It will be one of the objects of the coming World's Fair to show the most important manufacturing processes of the present day in operation, and for comparison with these the methods used in other countries when Columbus discovered the New World. In view of the wide attention that will be thus drawn to the past and present of our great industries, we feel that we can not offer our readers anything more acceptable at the present time than the series above outlined. The wonderful increase in the quantity of goods that one man's labor will turn out, the improvement in their quality, the reduction of the cost of manufacture together with the steady rise in wages during the period covered by these articles, are all due to the aid which science has afforded to the world's workers, and this is only a fraction of the field in which the influence of this great agency is active.

LITERARY NOTICES.

THE PRINCIPLES OF PSYCHOLOGY. By WILLIAM JAMES. American Science Series, Advanced Course. In two vols. New York: Henry Holt & Co. Price, $6.

PROF. JAMES is Professor of Psychology in Harvard University, and this work embodies his class-room instruction in that subject. It is a large work. The first volume contains 689 pages and the second 704 pages. The type is admirable and the illustrations are fresh and well adapted to their purpose. The author says in the preface that he has throughout kept close to the point of view of natural science. He rejects both the associationist and spiritualist theories. His ground is that thoughts and feelings exist and are vehicles of knowledge, and that Psychology, when she has ascertained the empirical correlation of the various sorts of thought or feeling with definite conditions of brain, can go no further. By attempting to explain thought and feeling as products of something deeper, she becomes metaphysical, and Mr. James claims that in dealing with psychology he is strictly a positivist—indeed, this is the only feature of the work for which he claims originality. The author says it is "a mass of descriptive details running out into queries which only a Metaphysics alive to the weight of her task can hope successfully to deal with. That will perhaps be centuries hence; and meanwhile the best mark of health that a science can show is this unfinished seeming front." It is thus seen that although Mr. James deals with the science of psychology as a positivist, he still has faith in metaphysics, and it is this circumstance, it seems to us, that gives the work its most characteristic quality. His style, which is always clear and forcible, is never so brilliant as when he is discussing metaphysical questions. In stating the various theories of the different schools of philosophy he does not conceal his own preferences. Indeed, he is too much in earnest in his beliefs not to be a partisan. And being by descent both a metaphysician and rhetorician, while his science is more of to-day, his inherited tendencies now and then get the better of his scientific judgment.

In Chapter I, On the Scope of Psychology, Mr. James limits his field of inquiry by taking as his criterion of mind "the pursuance of future ends and the choice of means for their attainment." This view answers his purpose much better than would a nearer approach to the "point of view of natural science." The scientific psychologist usually begins with the earliest phenomena of consciousness and the first traces of nervous organization, and uses his earlier results to explain the more complex phenomena encountered later on in his inquiries. But Mr. James is catholic enough to say that

"the boundary line of the mental is certainly vague. It is better not to be pedantic, but to let the science be as vague as its subject, and include such phenomena [instinctive and reflex acts of self-preservation] if by so doing we can throw any light on the main business in hand." He recognizes that at a certain stage in every science vagueness best consists with fertility, and quotes in illustration the Spencerian formula that life consists in "the adjustment of inner to outer relations," which he says has done much real service in psychology though it is "vagueness incarnate." He further says that "because it takes into account the fact that minds inhabit environments which act on them and on which they react; because, in short, it takes mind in the midst of all its concrete relations, it is immensely more fertile than the old-fashioned rational psychology which treated the soul as a detached existent, sufficient unto itself, and assumed to consider only its nature and properties. I shall, therefore, feel free to make any sallies into zoölogy or into pure nerve-physiology which may seem instructive for our purposes." The whole book, we are told, will be more or less a proof of the proposition that the *brain* is the one immediate bodily condition of the mental operations.

Accordingly, Chapter II treats through 78 pages of the Functions of the Brain, and Chapter III, of over 20 pages, considers the General Conditions of Brain Activity. These two chapters embody the latest assured results of experiment and observation, along with much comment and elucidation, and are very interesting and instructive. In Chapter IV the subject of Habit is dealt with in a most practical and impressive manner. The author supports his statements by liberal quotations from Dr. Carpenter's Mental Physiology. He closes with six or seven pages upon the Ethical Implications of the Law of Habit, addressed chiefly to the young, and bearing on the formation of character. Chapter V, on the Automatic Theory, and Chapter VI, on Mind-stuff, are lively, controversial, theoretical, all-sided, and strikingly display both the author's gifts of expression and peculiarities of method. Beginners are warned against several chapters in the book as too metaphysical, the one on Mind-stuff among them. If the trusting neophyte could read this chapter understandingly, it is hard to imagine the state of mind produced in him by the concluding paragraph, wherein all the points that have just been so conclusively refuted are affirmed to be, in the present state of our knowledge, the only ground of a scientific psychology. This backing and filling seem very odd in a text-book; but the author evidently can not help it. His aptitudes and tendencies are too strong to be resisted. And perhaps this non-committal, bantering, disputatious way of presenting all sides of the subject is the best possible one for the author's purpose as a teacher.

Chapter VII, on The Methods and Snares of Psychology, and Chapter VIII, on The Relations of Mind to Other Things, are also too difficult for beginners. They treat of the "outer world of objects and relations to which the brain states correspond."

In Chapter IX, on The Stream of Thought, the author enters upon the exposition of mind from within, or subjective psychology. Instead of adopting the synthetic method, and beginning, as is usual, with sensations, he begins with the process of thinking, which is treated analytically. He rejects the idea that because sensations are the simplest things they should be taken up first, and affirms that "the only thing which Psychology has a right to postulate at the outset is the fact of thinking itself, and that must first be taken up and analyzed." In this chapter he treats the subject of consciousness in a general way, and in Chapter X he discusses The Consciousness of Self. More than half of this long chapter of 110 pages is devoted to Pure Self, and treats of the Spiritualist Theory, the Associationist Theory, and the Transcendentalist Theory. He winds up the section upon The Soul Theory with the following words: "My final conclusion, then, about the substantial soul is that it explains nothing and guarantees nothing. Its successive thoughts are the only intelligible and verifiable things about it, and definitely to ascertain the correlations of these with brain-processes is as much as Psychology can empirically do."

One section of this chapter treats of The Mutations of Self, both normal and abnormal. The abnormal alterations are classed as

—(1) insane delusions; (2) alternating selves; (3) mediumships or possessions, and their discussion is popular, anecdotal, and tolerant, as becomes a member of the Society of Psychical Research. Mr. James tries to interpret the phenomena of mediumship. He speculates on the brain-condition during perversions of personality, and says "we must suppose the brain capable of successively changing all its modes of action, and abandoning the use for the time being of whole sets of well-organized association paths. And not only this, but we must admit that organized systems of paths can be thrown out of gear with others so that the processes in one system give rise to one consciousness and those of another system to another *simultaneously* existing consciousness."

Chapter XI, on Attention, discusses the question whether this is a faculty or a resultant—a cause or an effect. The author accuses the psychologists of the English empiricist school, naming Locke, Hume, Hartley, the Mills, and Spencer, of neglecting to notice it at all, and explains the motive of this ignoring by saying that "these writers are bent on showing how the higher faculties of the mind are pure products of 'experience'; and experience is supposed to be of something simply *given*. Attention, implying a degree of reactive spontaneity, would seem to break through the circle of pure receptivity which constitutes 'experience,' and hence must not be spoken of under penalty of interfering with the smoothness of the tale." The following extracts from his summary of the chapter may be taken as a fair sample of his style, and of his mode of dealing with subjects.

Mr. James says that he inclines to the cause-theory; but he also says that, "as regards immediate sensorial attention, hardly any one is tempted to regard it as anything but an effect." And, again: "Derived attention, where there is no bodily effort, seems also most plausibly to be a mere effect." And, again: "Even where the attention is voluntary it is possible to conceive of it as an effect and not a cause, a product and not an agent." Viewing it thus he says: "The stream of our thought is like a river. On the whole, easy flowing predominates in it, the drift of things is with the pull of gravity, and effortless attention is the rule. But at intervals an obstruction, a set-back, a log-jam occurs, stops the current, creates an eddy, and makes things temporarily move the other way. If a real river could feel these eddies and set-backs as places of effort, 'I am here flowing,' it would say, 'in the direction of greatest resistance. My effort is what enables me to perform this feat.' . . . The agent would all the while be the total downward drift of the rest of the water, forcing *some* of it upward in this spot. . . . Just so with our voluntary acts of attention. They are momentary arrests, coupled with a peculiar feeling of portions of the stream. . . . But the feeling of effort may be an accompaniment more or less superfluous, and no more contribute to the result than the pain in a man's finger when a hammer falls on it contributes to the hammer's weight. Thus our notion that our effort in attending is an original faculty, of which brain and mind are the seat, may be an abject superstition. Attention may have to go like many a faculty once deemed essential. It may be an excrescence on psychology. No need of it to drag ideas before consciousness or fix them, when we see how perfectly they drag and fix each other there."

Then, after this persuasive statement of the effect-theory, he gives the other side a chance by answering the question as to "what the effort to attend would effect if it were an original force." "It would deepen and prolong the stay in consciousness of innumerable ideas which else would fade more quickly away. The delay thus gained might not be more than a second in duration—but that second might be *critical*; for in the constant rising and falling of considerations in the mind, where two associated systems of them are nearly in equilibrium, it is often a matter of but a second, more or less, of attention at the outset, whether one system shall gain force to occupy the field and develop itself, and exclude the other, or be excluded itself by the other. When developed it may make us act, and that act may seal our doom. The whole feeling of reality, the whole sting and excitement of our voluntary life, depend on our sense that in it things are *really being decided* from one moment to another, and that it is not the dull rattling off of a chain that was forged innumerable ages ago. This appearance, which

makes life and history tingle with such a tragic zest, *may* not be an illusion. As we grant to the advocate of the mechanical theory that it *may* be one, so he must grant us that it may *not*. And the result is two conceptions of possibility face to face with no facts definitely enough known to stand as arbiter between them." And he adds that one can leave the question open, or let one's general philosophy incline the beam. In his own case, for ethical reasons unstated, he sides with the believers in the cause-theory, or that consciousness is a spiritual force.

The remainder of Vol. I is Chapter XII, Conception; Chapter XIII, Discrimination and Comparison; Chapter XIV, Association; Chapter XV, The Perception of Time; Chapter XVI, Memory. They are spirited and in esting, and especially instructive to teachers.

The opening chapter of Vol. II is upon Sensations, and discusses such general questions as the Cognitive Function of Sensation and The Relativity of Knowledge, which answers the question whether our objects of knowledge contain absolute terms or consist altogether of relations. These sections occupy twelve pages of the chapter, and the remaining thirty pages are devoted to The Law of Contrast. Then follows the chapter on Imagination, which contains an especially interesting section upon the differences of individuals in the power of imagination. The work done in this field by Fechner and Galton is set forth, and Mr. James gives also the results obtained from his own psychology-students' descriptions of their power of visual imagination. The entire chapter is very readable, although less disputatious than usual. The next three chapters are upon The Perception of Things, The Perception of Space, and The Perception of Reality, the two latter being among those the beginner is advised to omit on a first reading. The chapter on Reasoning is popular and entertaining. Of course, Mr. James insists on the intellectual contrast between brute and man, and does not admit any of the instances adduced by evolutionists to prove that the essential mental process involved in reasoning is sometimes exhibited by dogs and elephants. The chapters enumerated occupy 382 pages of the volume. The next three chapters, occupying 200 pages, are upon Instinct, The Emotions, and Will. There is a short chapter on Hypnotism, in which the various theories concerning it are discussed in the usual vein. These theories are (1) Animal Magnetism; (2) Neurosis; and (3) Suggestion, the latter of which, Mr. James says, is quite triumphant at the present day over the neurosis theory, as held at the Salpêtrière.

The last chapter in the book, on Necessary Truths and the Effects of Experience, is an elaborate effort to discredit all attempts of the experience philosophy to explain the genesis of our mental structure. As Mr. Spencer is the thinker who has done most in this direction, of course it is his especial doctrines that are first of all overthrown. This is done in the usual way by means of half statements and unwarranted assumptions. To gain his point he regards the process of adaptation, which Mr. Spencer calls direct equilibration, as the way of experience proper, the front-door way; but the process which Darwin named "accidental variation," and which Mr. Spencer terms indirect equilibration, he calls the back-door way, and says: "Both these processes are of course natural and physical; but they *belong to entirely different physical spheres*." (The Italics are ours.) This is a pure assumption, the contrary of which is made more and more manifest as the observations of naturalists are extended. Yet on this assumption the meaning of experience is given as "*processes which influence the mind by the front-door way of simple habits and association*" (the Italics are the author's); and back-door processes are said to be "pure *idiosyncrasies*, spontaneous variations, fitted by good luck to take cognizance of objects without being in any intelligible sense immediate derivations from them." It is in such ways as this that Mr. James is able to be both scientist and metaphysician, evolutionist and anti-evolutionist, as the peculiarities of his own mind determine.

A Text-book of Comparative Physiology. By Wesley Mills, M. D., D. V. S. New York: D. Appleton & Co. Pp. 636. Price, $3.

Like the author's Text-book of Animal Physiology, recently published, this work is designed primarily for students and practitioners of veterinary medicine. It is intended to replace the text books of human physi-

ology, which such students have been using, with something adapted to their special needs. The physiology of man is so different from that of most of the domestic animals, that books of the former class are very unsatisfactory for the use of veterinary students. Prof. Mills has accordingly prepared a volume somewhat smaller than his Animal Physiology, embodying the same general plan, but with greater specialization for the domestic animals. The plan of both books is thus described: "I have endeavored to set before the student a short account of what has been deemed of most importance in general biology; to furnish a full account of reproduction; to apply these two departments throughout the whole of the rest of the work; to bring before the student enough of comparative physiology in its widest sense to impress him with the importance of recognizing that all medicine, like all science, is, when at its best, comparative; and to show that the doctrines of evolution must apply to physiology and medicine as well as to morphology." Its comprehensive scope and clearness of style make it an excellent introduction to the study of comparative physiology for the use of the general student. The volume is finely printed and contains 476 illustrations. Among the pictures of especially wide usefulness are several pages of cuts showing the appearance of the teeth of horses, oxen, and other domestic animals at different ages.

AN AMERICAN GEOLOGICAL RAILWAY GUIDE. By JAMES MACFARLANE, Ph. D. Second edition, revised and enlarged. Edited by JAMES R. MACFARLANE. New York: D. Appleton & Co. Pp. 426. Price, $2.50.

THERE are three classes of people whom this book is intended to serve: first, the general traveler who is interested in the interpretation of the various aspects of nature; second, geologists, and especially students of geology; and, third, those who wish to know where useful minerals are likely to be found. The body of the work consists of lists of the stations on the railroads of the United States, Canada, and Mexico, with the name of the geological formation at each place. The distance of each station from one terminus of the road is given, and the altitude above sea-level of most. Prefixed to these lists are descriptions of the geological formation "intended for railway travelers who are not versed in geology." A multitude of foot-notes give interesting facts in addition to the information contained in the lists. To the traveler this work offers an opportunity to learn something of geology during the usually tedious hours of railway journeys; to the geologist it will furnish aid in selecting routes for geological excursions; to the man interested in the material development of new regions it may serve as a key to the capabilities of any given locality as regards products of the soil and underground wealth. The second edition, edited by the son of the author, contains twice as much matter as the first. The editor has had the assistance of the State Geologist or of some other gentleman well acquainted with the local geology in each State. The lightness which the traveler demands in what he carries has been secured in this volume by the use of thin but tough paper and a strong, flexible cloth cover.

ECONOMIC AND SOCIAL HISTORY OF NEW ENGLAND: 1620–1789. By WILLIAM B. WEEDEN. In two volumes. Boston: Houghton, Mifflin & Co. Price, $4.50.

HISTORY, which formerly chronicled only the doings of kings and chieftains, and later developed into the life-record of the state, has now extended its scope to the affairs of the people. Its field is thus made to include a multitude of forces, individually small but mighty in the aggregate, which have always had a potent influence in shaping the courses of nations and in causing the success or the overthrow of rulers. Events otherwise inexplicable are seen to be natural sequences, when the temper of a people becomes known as revealed in their conduct of commercial, social, religious, and family affairs. Probably no region with an equal length of history is so rich in materials for a record of social life as New England. The early New-Englanders conscientiously recorded their business and public transactions, and complacently wrote out their ideas and opinions upon current topics, and later generations have proudly preserved these memorials. Hence the wealth of detail that Mr. Weeden has been able to include in his panorama. Among the important institutions of New England to which the author early calls attention are the towns. These, he states, "were founded on

three leading principles: (1) Freehold land regulated by the best usage of many centuries. (2) A meeting, the local and social expression of religious life and family culture. (3) A representative democratic gathering, corresponding to the old folk-mote of the Germanic races." We find town regulations affecting all the affairs of daily life, even some of the most minute and personal. Many of them had to be repealed almost as soon as made; yet the fact that others were allowed to stand and were tolerably observed shows in the colonists a great reverence for the wisdom of the majority. The approved method for dividing the land in a town was that each grantee should have a home lot near the "place for Sabbath assembly," and a field for cultivation farther away. There were also tracts for pasturing the cattle in common herds. The holding and transfer of real estate were among the matters closely regulated. Dorchester, in 1634, enacts that "no man within the Plantation shall sell his house or lott to any man without the Plantation, whome they shall dislike off." In Nahant, colonized by Lynn in 1657, the householders are to have lots of equal size, "noe man more than another." The co-occupation of the country with the Indians had its influence on the customs of the colonists, and the trespasses which the latter committed upon their red-skinned brethren reveal some weaknesses of the Puritans' character that their religion did not save them from. Church and civil government were closely interwoven. In Massachusetts and Connecticut the franchise depended on connection with the church; on the other hand, ministers were commonly chosen in open town meeting, and marriages were performed only by magistrates. The trade in beaver-fur and that in cured fish were of much importance. Permission to keep taverns was voted as early as 1630, but inn-keepers must not force meals at 12*d.* and above on "pore people." The sale of wines and liquors was wholly prohibited in the Massachusetts Bay Colony in 1637, but the very next year licenses began to be granted. Ship-building and commerce had a rapid growth, and the colonial merchants were soon able to build "fair and stately houses." Many industries were early established; the first saw-mill was set up at Piscataqua (Portsmouth, N. H.) in 1631. Grist-mills were already in use. Nicholas Easton established a tannery at Ipswich in 1634. Goodman Fitt, a tailor, is empowered by Charlestown "to set up a salt pan, if he can live upon it, and upon his trade." In 1639 John Hull notes in his diary, "We began to print at Cambridge." Iron-works were established at Lynn in 1643, and at Braintree soon after. Among the colonial laws none seem now so quaint and preposterous as those regulating manners and morals. The "blue laws" of Connecticut are proverbial. In that colony no food or lodging could be given to a Quaker, Adamite, or other heretic. Whoever brought cards into the dominion paid a fine of five pounds. No one could read common prayer, keep Christmas or saints' days, make mince pies, dance, play cards, or play on any instrument of music except the drum, trumpet, and jew's-harp. Tobacco must not be taken "publiquely in the street, highwayes, or any barne-yards, or uppon traineing days in any open places." Massachusetts made rules no less meddlesome. Sunday observance and economical dress were strictly enforced. Class distinctions were strong, and often caused much bitterness. They ruled the seating of the people in church; thus Stamford, Conn., in 1673 votes to seat its people according to "dignity, agge, and estate in this present list of estate." At Saco, in 1669, two men were voted into the first seat, and their wives into the third. Tithing-men with long staffs, having a knob at one end and a fox-tail at the other, rapped or tickled the sleepers in meeting. The above is a sample of the material that fills Mr. Weeden's nine hundred pages. Among the other topics upon which he gives information are means of travel and communication, agriculture, forced service of Indians which was followed by negro slavery, currency of wampum, coin, and paper, privateers and pirates, whaling, the East India trade, the lives of notable men of the time—such as Hull, the Pepperells, Sewall, Amory, the Faneuils, Edwards, Franklin, and Derby—and the effects of England's regulations upon colonial life and commerce. The sources from which Mr. Weeden has drawn his material include the archives and probate records of Massachusetts, Rhode Island, and Connecticut, manuscripts and newspapers

in the possession of various historical societies, the diaries of John Hull and Judge Sewall, and various town histories and other historical works. Numerous specific references to sources are given in foot-notes. Appendixes contain a list of prices of labor and commodities in different years from 1630 to 1789, examples of early accounts, reminiscences of Samuel Slater, the first cotton manufacturer in America, etc. An index of fifty pages makes all the references to any topic easily accessible.

OUTLINES OF GENERAL CHEMISTRY. By WILHELM OSTWALD, Professor of Chemistry in the University of Leipzig. Translated by JAMES WALKER, D. Sc. London and New York: Macmillan & Co. Pp. 396. Price, $3.50.

THIS is a work on chemical philosophy adapted to college students who have some acquaintance with descriptive chemistry. An especially notable feature of it is the pains taken by the author to make his subject plain, and to give the student just ideas in regard to the relative importance and trustworthiness of the results which the science has thus far attained. To this fact the large size of the volume is chiefly due. As it is not designed for those who intend to go into the higher aspects of the science, the higher mathematics has not been employed. Another feature of the work is the connected account it gives of the discoveries of van't Hoff in regard to solution and those of Arrhenius concerning electrolytic dissociation, made within the last three or four years, and not yet generally recognized by English-speaking chemists. The translating is evidently well done, but the inconvenient German style of index is retained.

The papers and discussions found in the *Circular of Information No. 2*, issued by the United States Bureau of Education in 1889, are especially valuable to those interested in the question of educational methods. In The Relation of Manual Training to Body and Mind, Prof. Woodward gives an outline of the work undertaken in the St. Louis Manual Training School. This department of Washington University has been in operation nine years, and the *verbatim* reports of parents show that the students are not only physically benefited by this system, but accomplish as much mentally and develop greater zest for acquirement than when trained merely in an intellectual direction. Dr. Harris, treating of the psychology, gives his reasons for preferring the drill in reading, geography, arithmetic, and especially grammar, to any discipline in tool-work. He insists upon the distinction between higher and lower faculties; that "we do not get at the true reality by sense perception but by thought"—"man elevates himself above the brute creation by his ability to withdraw his attention from the external world of the senses and give attention to forces, causes, principles." The province of the school, therefore, is to make the pupil master of the tools of thought, to furnish him "with means for availing himself of the mental products of the race." Superintendent Seaver gives, as a result of experience, that "such instruction takes a strong hold on the minds of a large class of boys who are either not so well reached, or not reached at all, by the subjects and methods of teaching current in the older high schools." Other suggestive papers are those on Psychology in its Relation to Pedagogy, by Dr. Butler; How can Manual Training be introduced into Ungraded Schools? by Prof. Allen; and The State and Higher Education, by Superintendent Campbell and Prof. Adams. The discussions on the training of teachers and on the value of examinations will tend to alter the gauge of any narrow-minded educator who may read them.

A *History of Education in Alabama*, prepared by Willis G. Clark, is the subject of *Circular of Information No. 3*, 1889. This is the eighth monograph in the series, and, apart from its historical and local worth, it is deserving of study as an exhibit of intellectual growth remote from well-recognized centers. The fact that Alabama has possessed a State institution of learning for seventy years, supplying from one of her professors a President for Columbia College—the late Dr. Barnard—and that Howard College, in the same State, has furnished Harvard with a Professor of Hebrew and Assyrian, shows that the East and North do not monopolize thoroughness in scholarship. It is well to learn that "the Southern city of Mobile, in 1853, could boast of a public-

school system with methods as advanced . . . and discipline as effective as in the justly famed schools of New England." As early as 1867 the public-school commissioners acted in concert with the Freedman's Bureau to extend education to colored children. The report for 1888 shows an enrollment in the schools of 98,919 colored pupils, with salaries paid to colored teachers amounting to $183,933.97. Among the State institutions enumerated as *educational* is the Alabama Insane Hospital. The classification is scarcely warrantable, although the leading forth and restoration of mind rest on the same psychological basis. The institution is worthy of note on its own account. Under the care of the distinguished alienist, Dr. Boyce, 1,011 patients are managed without mechanical constraint, healthful and varied occupation having been substituted for irrational confinement and isolation. This pamphlet is fully illustrated with views of colleges, library, and laboratory interiors.

In the preface to *A Report on Medical Education, Medical Colleges, and the Regulation of the Practice of Medicine in the United States and Canada*, it is asserted that there has been greater progress in the direction of a higher medical education in the year 1889 than in the preceding five years. Various States have made obligatory a preliminary examination of those intending to pursue medical studies, and three additional States have passed acts requiring, as a condition of practice, evidence of graduation at a medical college in good standing, or, a satisfactory examination by an authorized board. Twenty-seven colleges now insist upon four years' study and three annual courses of lectures, while only four made such requirement in 1889. It is suggested that the standard will be further advanced in seven institutions by the provision of *four* annual series of lectures. The total number of colleges now in existence in the United States and Canada is given as one hundred and thirty-nine; forty-seven of these are open to both sexes. More than a hundred colleges have chairs of Hygiene and Medical Jurisprudence; lectures on bacteriology are given in six colleges and two post-graduate schools, while a large number afford laboratory practice. The information furnished by the pamphlet includes titles, locations, addresses of corresponding officers, curricula of study, fees, number of matriculates and graduates. The records of a large number of fraudulent institutions are also given. The data are arranged in alphabetical order as to States; but a full index is appended, by means of which any medical school may be readily located.

In the *Educational Value of Manual Training*, Prof. C. M. Woodward dissects the arguments contained in a report on the subject made to the Council of Education in July, 1889. To ground the reader fairly in the debate, the report itself is printed in full, also a critical review of it, by Gilbert B. Morrison. The author fears that the report, which has been published many times, may lead to wrong inferences concerning manual training. It is the fugitive side-discussions and incidental definitions to which he objects. He discusses the curriculum of the manual training school; school tool-work *vs.* trade-work; the age of pupils; relation to social evils; comparison with pure science; intellectual powers; the economic value, and the argument against liberal culture in tool-work. The gist of the matter appears to be that, while the committee considers manual training *per se*, Prof. Woodward urges that *the system* of manual training—i. e., intellectual, scientific, and manual combined—shall be the subject of investigation.

The spread of educational interest is illustrated in *A Short History of the Educational Society of Japan*, 1890. It is published by the society, and printed at the Tsukijo Kwappan Teizōsho, Tōkyo, Japan. The present association is the resultant from the union of two former societies, and it has been in existence six years. Its outlook is flourishing. It issues a journal, of which 331,559 copies have been published and has a library of 28,140 volumes, including 750 European books as well as Japanese and Chinese works. Rules for the government of the society are given, and to these is added a list of the patrons, officials, and members. His Imperial Highness Prince Arisugawa Taruhito, is honorary president of the society.

A course of *Progressive Exercises in Practical Chemistry* has been prepared by Dr. *Henry Leffmann* and Mr. *William Beam*

(Blakiston). It includes the exercises that have been given for several years in the Woman's Medical College and in the Pennsylvania College of Dental Surgery, in Philadelphia. The first fourteen pages are devoted to descriptions of apparatus and manipulations, illustrated with forty-two cuts. The rest of the book is occupied by directions for 253 experiments arranged to illustrate successively the general principles of chemistry, the properties of the important elements, and electrical decomposition. The authors state that they have "given much attention to details as to quantity of materials to be used and arrangements of apparatus. Some of the experiments and forms of apparatus are new, and have been devised especially with a view to economy." The book is "adapted for use in conjunction with any manual of elementary chemical principles, or to be supplemented by lectures."

Henry C. Northam has prepared a *Manual of Civil Government* (Bardeen), intended for public instruction in the State of Missouri. It is arranged in the form of a catechism, and takes up the history of the organization of the Government of the United States; city, village, and State government as existing in Missouri, giving the duties and salary of each officer; the organization and jurisdiction of the various courts; presidential elections; the two Houses of Congress; etc. The Declaration of Independence and the Constitution of the United States are appended. The State Constitution of Missouri is not given.

A little calisthenic manual, entitled *Home Exercise for Health and Cure*, by *D. G. R. Schreber, M. D.*, has been translated by *Charles R. Bardeen* (Bardeen). It consists of directions for forty-five exercises which require no apparatus. These are followed by combinations of the exercises, adapted to different forms of weakness and to the daily needs of persons of different ages and both sexes. General suggestions and remarks precede and follow the above matter. Where clearness requires it the exercises are illustrated. The publisher states that in Germany teachers are expected to be familiar with the book, and that 140,000 copies of it had been sold up to 1889.

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POPULAR MISCELLANY.

Philosophy at Harvard.—The courses of study in philosophy that are offered to students by Harvard University for the year 1890–'91 number seventeen. In the elementary courses, students attend one, two, or three lectures or recitations a week, as the case may be. Advanced students carry on their studies mostly by themselves, meeting for a conference with the professor once a week. The facilities for philosophical study at Harvard have about doubled within the last ten years. In 1880–'81 there were ten courses in philosophy for undergraduates and graduates, two of which were given only in alternate years, the instructors being Prof. Bowen, and Asst. Profs. Palmer and James. These dealt with logic, psychology, ethics, contemporary philosophy, earlier English, French, and German philosophy, German philosophy of the present day, and the history of philosophy. Courses covering substantially the same ground are given now, besides which four courses given in the Divinity School, on the philosophy of religion, are open to general students of philosophy, and there have been added a course on Greek philosophy and three which deal with modern thought and modern problems. One of these last is called Cosmology: a Discussion of the Principal Problems of the Philosophy of Nature, with Special Reference to the Doctrine of Evolution, and embraces lectures by the professor and the writing of theses by the students. For the current year three theses upon assigned topics will be required, and are to be based upon the private reading of Herbert Spencer's First Principles, and of Le Conte's Evolution in its Relations to Religious Thought, and other reading to be announced. Another of the newer courses deals with the ethics of the social questions—charity, divorce, the Indians, temperance, and the various phases of the labor question. The mode of study includes lectures, essays, and practical observations. There are also three "seminaries" for advanced students—a psychological, a metaphysical, and an ethical—and guidance will be furnished to students who wish to take up individual investigations of questions in ethics. In the psychological seminary the subject for the current year is Pleas-

ure and Pain, and it will be studied by means of lectures, essays, and laboratory work. The present officers of the Philosophical Department are Profs. G. H. Palmer, A. M., C. C. Everett, D. D., William James, M. D., and F. G. Peabody, D. D., Asst. Prof. Josiah Royce, Ph. D., and George Santayana, Ph. D., instructor.

The Founder of Inebriate Asylums.—A sketch of the late Dr. J. Edward Turner, founder of the first inebriate asylum in the world, has been published by T. D. Crothers, M. D., in The Quarterly Journal of Inebriety. Dr. Turner was born in Maine, in 1822, and had his mind turned to the subject of his life work by being called upon to take care of an inebriate uncle at intervals of several months, during his student life and after he began to practice medicine. When he first mentioned his idea of an asylum, where such cases could be secluded, housed, and treated, it was received with derision and contempt. He went to Europe in 1843, and spent two years visiting hospitals and asylums, and discussing his ideas with medical men. On his return he began the systematic collection of facts concerning inebriety. About this time Drs. Valentine Mott and John W. Francis became interested in his plan for an asylum, and continued all their lives to be his warmest friends. There was much bitter opposition to the idea of treating drunkenness as a disease, and still more indifference to the matter, so that Dr. Turner made but slow headway. In 1848–'49 he made a second visit to Europe. After his return he began to solicit subscriptions to the stock of a company to build an inebriate asylum. A charter was obtained from the State of New York, and finally, in 1858, ground was broken at Binghamton for a building planned by Dr. Turner, and the erection of which he personally superintended. By persistent petitioning he obtained from the New York Legislature a grant of one tenth of the money obtained each year from liquor licenses, for the building and maintenance of the asylum. In 1862 Dr. Turner married. The building had progressed far enough in 1864 to open it for patients, and a number of inebriates were admitted. At this point success seemed to have crowned the efforts of the founder. He had won over public opinion to his side, and the most active interest was being manifested all over the State in the work. But trouble arose over the mode of treatment. Dr. Turner's system was military in its strictness, his first principle being, that the asylum officers should have full control of the patient, and that this control should extend over a long time, and not be governed by the will of the patient or his non-expert friends. An unscrupulous, money-getting lawyer in the board of directors, and a weak president of the board, caused a division, which was followed by persecution of Dr. Turner, and his resignation as superintendent in 1867. The asylum was then sold to the State for a nominal consideration, and thirteen years later was changed to an insane hospital, being known now as the New York State Insane Asylum at Binghamton. The transfer was not legally made, and Dr. Turner began a suit for possession of the property, which was never carried to an issue. Dr. Turner then undertook to raise subscriptions for a woman's hospital for inebriates and opium-eaters. After three years, the subscriptions in money and materials had reached a great amount, ground had been broken for a building, when the Legislature of Connecticut crushed the scheme by repealing the charter previously granted. For the next two years after this discouraging defeat Dr. Turner occupied himself with writing a book called the History of the First Inebriate Asylum in the World, which was a general account of his forty years' efforts. He then started out to sell the work, and to solicit aid to push his suit for the Binghamton asylum, and was busied thus when he died, July 24, 1889. Dr. Turner's career was a striking example of overwhelming defeat for the individual joined with signal triumph for his idea. Inebriety is being more widely recognized as a disease each year. There are to-day over one hundred inebriate asylums in the world, all the direct result of his efforts in founding the first one at Binghamton.

Origin of American Public Museums.—The first chapter in the history of American museums, says Dr. G. Brown Goode, in his lecture on museums, is short. In the early years of the republic, the establishment of

such institutions by city, State, or Federal Government would not have been considered a legitimate act. When the General Government came into the possession of extensive collections as the result of the Wilkes Exploring Expedition in 1842, they were placed in charge of a private organization, the National Institution, and later, together with other similar materials, in that of a corporation, the Smithsonian Institution, which was for a long period of years obliged to pay largely for their care out of its income from a private endowment. It was not until 1876 that the existence of a National Museum, as such, was definitely recognized in the proceedings of Congress, and its financial support fully provided for. In early days our principal cities had each a public museum, founded and supported by private enterprise. The earliest general collection was that formed at Norwalk, Conn., prior to the Revolution, by a man named Arnold, described as "a curious collector of American birds and insects." This it was which first awakened the interest of President John Adams in the natural sciences. He visited it several times, as he traveled from Boston to Philadelphia, and his interest culminated in the foundation of the American Academy of Arts and Sciences. In 1790 Dr. Hosack brought to America from Europe the first cabinet of minerals ever seen on this continent. The earliest public establishment was the Philadelphia Museum, founded by Charles Wilson Peale in 1785, which had for a nucleus a stuffed paddle-fish and the bones of a mammoth, and was for a time housed in the building of the American Philosophical Society. In 1800 it was full of popular attractions. The Baltimore Museum was managed by Rembrandt Peale, and was in existence as early as 1815 and as late as 1830. Earlier efforts were made, however, in Philadelphia. Dr. Chovet, of that city, had a collection of wax anatomical models made by him in Europe; and Prof. John Morgan, of the University of Pennsylvania, who learned his method from the Hunters, in London, and Sué, in Paris, had begun to form such a collection before the Revolution. The Columbian Museum and Turell's Museum, in Boston, are spoken of in the annals of the day; and there was a small collection in the attic of the State House in Hartford. The Western Museum, in Cincinnati, was founded about 1815, by Robert Best, M. D., afterward of Lexington, Ky., who seems to have been a capable collector, and who contributed matter to Goodman's American Natural History. In 1818 a society styled the Western Museum Society was formed among the citizens, which, though hardly a scientific organization, seems to have taken a somewhat liberal and public-spirited view of what a museum should be. With the establishment of the Academy of Natural Sciences in Philadelphia in 1812, and the New York Lyceum of Natural History, the history of American scientific museums had its true beginning.

The Question of Tertiary Man.—The antiquity of man and an account of anthropological museums were the chief topics discussed in the address of Mr. John Evans, President of the Anthropological Section of the British Association. The question of the antiquity of man, the author said, is susceptible of being separated from any speculations as to the generic descent of mankind; and even were it satisfactorily answered to-day, new facts might to-morrow come to light that would again throw the question open. On any view of probabilities, it is unlikely that we shall ever discover the exact cradle of our race, or be able to point to any object as the first product of the industry and intelligence of man. We may, however, the author thought, hope that from time to time fresh discoveries may be made of objects of human art, under such circumstances and conditions that we may infer with certainty that at some given point in the world's history mankind existed, and in sufficient numbers, for the relics that attest this existence to show a correspondence among themselves, even when discovered at remote distances from each other. After reviewing the course of discovery of prehistoric man, and the considerations on which the attempt is based to show that he existed in the Tertiary, Mr. Evans declared his conclusion that on the whole the present verdict as to Tertiary man must be in the form of "not proven." When we consider the vast amount of time comprised in the Tertiary period, with its three great principal subdivisions of the Eocene, Miocene, and Pliocene, and when we

bear in mind that of the vertebrate land animals of the Eocene no one has survived to the present time, while of the Pliocene but one—the hippopotamus—remains unmodified, the chances that man, as at present conditioned, should also be a survivor from that period seem remote, and against the species *Homo sapiens* having existed in Miocene times almost incalculable. The *a priori* improbability of finding man unchanged, while all the other vertebrate animals around him have, from natural causes, undergone more or less extensive modification, will induce all careful investigators to look closely at any evidence that would carry him back beyond Quaternary times; and though it would be unsafe to deny the possibility of such an early origin for the human race, it would be unwise to regard it as established except on the clearest evidence.

Embryological Recapitulation.—Prof. A. Milnes Marshall, in his presidential address before the Biological Section of the British Association, after remarking on the general subject of the study of embryology, spoke more particularly of its relation to the doctrine of recapitulation, which, suggested by Agassiz, had been elaborated by eminent contemporary zoölogists. Natural selection, he showed, explains the preservation of useful variations, but does not account for the formation and preservation of useless organs; but recapitulation solves the problem at once, by showing that those organs, though now useless, must have been of functional value to the ancestors of their present possessors, and that their appearance in the ontogeny of existing forms is due to the repetition of ancestral characters. Such rudimentary organs are, as Darwin has pointed out, of larger relative or even absolute size in the embryo than in the adult, because the embryo represents the stage in the pedigree in which they were functionally active. Rudimentary organs are extremely common, especially among the higher groups of animals, and their presence and significance are now well understood. Man himself affords numerous and excellent examples, not merely in his bodily structure, but by his speech, dress, and customs. For the silent letter *b* in the word doubt, or the *w* of answer, or the buttons on his elastic-side boots are as true examples of rudiments unintelligible but for their past history, as are the ear muscles he possesses but can not use, or the gill-clefts which are functional in fishes and tadpoles, and are present, though useless, in the embryos of all higher vertebrates. It was the elder Agassiz who first directed attention to the remarkable agreement between the embryonic growth of animals and their palæontological history.

The Scope of Mathematics.—Mr. J. W. L. Glaisher, President of the Mathematical Section in the British Association, in his address spoke of the range of subjects comprehended within the scope of mathematics. Its field extends from the most exact of all knowledge to branches of inquiry in which only uncorrelated facts have been collected. Considering pure mathematics, or that of the abstract sciences which could be conquered and explored only by mathematical methods, it is difficult not to feel somewhat appalled by the enormous developments it has received in the last fifty years. The mass of the investigations, as measured by the annual additions to the literature of the subject, is so great that it is fast becoming bewildering from its mere magnitude and the extraordinary extent to which many special lines of study have been carried. There can be no end to this. So wide and various are the subjects of research, so interesting and fascinating are the results, so wonderful are the fields of investigation laid open at each succeeding advance, that we may be sure that, while the love of learning and knowledge continue to exist, there can be no relaxation of our efforts to penetrate still further into the mysterious worlds of abstract truth that lie spread temptingly before the investigator. The speaker did not believe that the bearing of the modern developments of mathematics on the physical sciences is likely to be very direct or immediate, but it would be rash to assert that there is any branch of mathematics so abstract or so recondite that it may not at any moment find an application in some concrete subject. Still, it appears that if the extension of the pure sciences can only be justified by the value of their applications, it is very doubtful whether a satisfactory plea for any further developments can be sustained. Although

the condition of mathematical science in England is not fully satisfactory, there is more cause for congratulation at present than there has been at any time during the last one hundred and fifty years, and we are far removed from the state of affairs that existed before the days of Cayley and Sylvester. The author concluded with a plea for the study of the theory of numbers.

Value of Living Traditions.—According to Mr. J. G. Frazer, the author of a comparative study of religions, entitled the Golden Bough, the best source for knowledge of ancient folk-lore is among the people of the present. Every inquiry into the primitive religion of the Aryans, he says, "should either start from the superstitious beliefs and observances of the peasantry, or should at least be constantly checked and controlled by reference to them. Compared with the evidence afforded by living tradition, the testimony of ancient books on the subject of early religion is worth very little. . . . The mass of the people who do not read books remain unaffected by the mental revolution wrought by literature; and so it has come about that in Europe, at the present day, the superstitious beliefs and practices which have been handed down by word of mouth are generally of a far more archaic type than the religion depicted in the most ancient literature of the Aryan race."

The Magnetograph.—The magnetograph, the adaptability of which to use as a seismoscope has been tried by Prof. T. C. Mendenhall, is described by him as a system of magnetic needles, free to vibrate, and connected with a mirror that turns with the needles. It has long been noticed that an earthquake causes a considerable disturbance of the needles; and that this is not an effect of vibration is shown by the fact that a series of brass needles is not thus disturbed. It appears from the study of the magnetic records that there are two distinct vibrations, one due to solar influence and seeming to be dependent jointly on position and temperature; the other series were dependent on the relative position of the earth and the moon, and were therefore regarded as of a tidal nature; and the disturbances of the magnetic needle may be, and probably are, due to the stress of the earth's crust. The author mentioned as a remarkable fact that a periodic disturbance, smaller in amplitude than the thickness of the line recorded, could be positively and perfectly determined. This evidence that the lunar influence is due to variation of stress furnishes a clew to the explanation of the disturbances due to earthquakes. The stress to which the earth is then subjected causes an alteration in its magnetic condition which is recorded upon the sheet. It may therefore be possible to recognize an earthquake by disturbance of the magnetic needle, even when the motion is too small to be recognized by a seismoscope. It is a curious fact that it is supposed in Japan that an earthquake can be predicted by the vibrations of a loadstone.

The Natural Gas Supply.—The permanence of the natural gas supply was discussed in the American Association, which, meeting in the heart of the natural gas region, visited some of the more famous stations at Noblesville, Marion, Muncie, and Anderson, where the new fuel is used. President Goodale warned the people at Anderson against waste of the gas, because, he said, it will surely give out some day. Dr. Edward Orton affirmed in a paper in the Economic Section that the supply in the Indiana and Ohio fields is not only exhaustible, but is rapidly and surely being exhausted. It is not now being generated, and every foot that escapes to the surface leaves the quantity remaining for future use just so much smaller. This is proved by the fact that the pressure of the gas is steadily diminishing, the decrease having already amounted to thirty or forty per cent. Prof. P. H. Vander Weyde is of a different opinion. He believes that the gas is formed in much the same manner as water-gas; that the evolution of oxygen and hydrogen is constantly going on in the regions of the earth's interior, where the temperature of dissociation exists; and that when carbureted metals having great affinity for water are present within reach of the dissociated gases, they will be oxidized by the ascending oxygen, while the hydrogen will combine with the carbon to form hydrocarbons. Thus the process of generating the gas is going on all the

time, and the prospect for the continuation of the supply is cheerful. "Look," the author says, "at the burning gas-wells of Baku, where the gas escapes by fissures in the soil, and has been blowing and burning for centuries, and all for nothing thus far. There appears to be no diminution in their flow, while from the Chinese historical records it appears that natural gas has been evolving in more than one locality for at least a thousand years, and I expect the same here. It comes from regions far below the deepest coal mines, and may continue to flow when some mines are exhausted."

Geography-teaching in Russia.—The object of a paper in the British Association, by Dr. H. R. Mill, on Geographical Teaching in Russia, was to give an idea of the method of instruction as prescribed by the official syllabus enforced in government and private schools. The books are generally illustrated by black and white maps, and by diagrams of great interest and ingenuity, exemplifying statistics in graphic form. It is characteristic of the Russian system to go deeply into statistics. The absence of pictures in the instruction books is noticeable, but subjects are treated exhaustively. Greater attention is paid to ethnography than in the system of any other country, because, probably, of the many races among which the subjects of the Czar are divided. Russians are in the habit of regarding Asia rather than Europe as nearest to them.

Coffee-drinking.—Dr. Mendel, of Berlin, has recently published a clinical study on Coffee Inebriety. His observations were made upon the women of the working population of Essen, a town in Prussia, Department of Dusseldorf. He found large numbers of women who used over a pound of coffee a week. The leading symptoms are profound depression, frequent headache, and insomnia. A strong dose of coffee relieves this for a time; a partial loss of power over the muscles occurs, and an increasing aversion to labor. The heart's action becomes rapid and irregular. Dyspepsia of an extreme nervous type is present. Brandy offers only a temporary relief. The face becomes sallow and the hands and feet cold. Acute inflammation is likely to occur; an injury to any part of the body is the starting point for inflammation of an erysipelatous character. Melancholy and hysteria are common symptoms. Many opium and alcoholic cases have an early history of excessive use of coffee.

The Dangers of the Present Mode of Burial.—Human effluvium from the living body, taken into the lungs or stomach, is a well-recognized cause of disease. That it is not, at the least, equally so from the body dead, especially when it is putrescent, is difficult to believe. The following, taken from Johnson on Tropical Climates (American edition, p. 83), is an illustrative case: "An American merchantship was lying at anchor in Whampoa Roads, sixteen miles from Canton. One of the crew died from dysentery. He was taken on shore to be buried. No disease of any kind had occurred in the ship during her voyage from America to the river Tigris. Four men accompanied the corpse, and two men began to dig the grave. Unfortunately, they pitched upon a spot where a human body had been buried two or three months previously (as was afterward ascertained). The instant the spade went through the lid of the coffin a most dreadful effluvium issued forth, and the two men fell down nearly lifeless. It was with the greatest difficulty that their companions could approach near enough to drag them from the spot and fill up the place with earth. The two men now recovered a little, and with assistance reached the boat and returned on board." Both died—one on the evening of the fourth and the other the morning of the fifth day—of a malignant fever, with symptoms resembling plague. The other two men, who were less exposed, were similarly affected, but recovered. That the poisonous emanations inhaled in this case would have been any less dangerous if swallowed with the subsoil water in the vicinity can be surmised by those only who believe inhumation of the dead to be without danger to the living.

An Early Form of Telegraphy.—Among the early devices for conveying information to a distance by means of signals the following is very ingenious. It was used by a Grecian general, Æneas, who flourished in

the time of Aristotle. It consisted of two exactly similar earthen vessels filled with water, each provided with a cock that would discharge an equal quantity of water in a given time, so that the whole or any part of the contents would escape in precisely the same period from both vessels. On the surface of each floated a piece of cork supporting an upright, marked off into divisions, each division having a certain sentence inscribed upon it. One of the vessels was placed at each station, and when either party desired to communicate with the other he lighted a torch which he held aloft until the other did the same, as a sign that he was all attention. On the sender of the message lowering or extinguishing the torch, each party immediately opened the cock of his vessel, and so left it until the sender relighted his torch, when it was at once closed. The receiver then read the sentence on the division of the upright that was level with the mouth of the vessel, and which, if everything had been executed with exactness, corresponded with that of the sender, and so conveyed the desired message.

NOTES.

Mr. John T. Campbell presented, in the American Association, the evidence in support of his belief that there was, in the Wabash River, one last great flood near the close of glacial time, and that then the water-supply was so cut off or diminished that there was never another freshet large enough to wipe out or modify the marks it left. This flood, in the opinion of the author, carried about one hundred times as much water as do the great floods of the present time.

The largest barometer yet made has been put in working order in the Saint Jacques Tower, in Paris. It is forty-one feet five inches high.

The International Medical Congress met in Berlin, August 4th. Members of the medical profession were present representing every state and city in Europe, and many from North and South America. An opening address of welcome was made by the president, Prof. Virchow. Welcoming addresses were also given for Prussia and Berlin. Dr. Lassar, Secretary-General of the Congress, sketched the general plan of the labors of the Congress, and gave some statistics concerning the representation of the countries taking part in it. Dr. Hamilton, Surgeon-General of the United States Army, was the first regular speaker, and was followed by Sir James Paget and Sir Joseph Lister.

The corrosion of steel by salt water is said to be much greater than that of iron. Mr. David Phillips stated, in a recent address before the British Institute of Marine Engineers, that he had experimented from 1881 to 1888 with two plates of Bessemer boiler steel, two of Yorkshire, and two of B. B. Staffordshire boiler iron. The plates were as nearly as possible six by six by three eighths inches, and were kept immersed in salt water. The results show a great difference between the behavior of steel and iron. The steels lost 120 per cent more than the irons the first three years, when the plates were in contact; 124 per cent more the second three years, when they were insulated; and 126 per cent more for the whole period of seven years.

Unless some of our investigators of bacteria are mistaken, there seems to be hardly a situation where these minute organisms may not be found. Thus Dr. Charles M. Cresson claims to have discovered typhoid bacilli in the juice squeezed from some celery grown near Philadelphia; and the Johns Hopkins Hospital Bulletin for May, 1890, records some observations, by A. C. Abbott, upon bacteria found in the interior of large hailstones which fell during the storm of April 26, 1890.

The Australasian Association for the Advancement of Science will hold its third annual meeting at Christchurch, New Zealand, beginning January 15,1891. Sir James Hector, F. R. S., will succeed Baron F. von Müller, F. R. S., as president, and will deliver an address. Arrangements are making to secure reduced excursion fares from the other Australian colonies, and probably from Great Britain.

In his lecture on caves, at the meeting of the American Association, the Rev. Dr. Hovey exhibited a photograph made by L. Farini, of Bridgeport, Conn., from an ordinary negative, by means of the light of the fire-fly (*Elator phocans*).

The object of certain experiments described by Mr. W. Sharp, in the British Association, was to answer the question, What is the action of the substances called drugs upon the living body of man? The conclusions arrived at were the results of experiments made upon men in sound health, with different quantities of the same drugs. In the case of fourteen drugs that were used it was found that the smallest doses administered have power to act upon the living human body; that the commonly received opinion that the actions of drugs are simply increased in degree, and not altered in character, by increasing the dose, is an error; and that the actions of drugs are sufficiently distinct to admit of classification.

An interesting account was given by the Rev. E. Jones, in the British Association, of his exploration of the Elbolten Cave, in Craven. The first chamber, the one examined, is between thirty and forty feet long, and from seven to thirteen feet wide. Relics, including remains of about a dozen men, were found in two strata. Among the objects discovered most worthy of notice were remains of a hearth, neolithic pottery, variously ornamented and coated with charcoal on the inside; pot-boilers made of rounded grit with marks of fire; pieces of silurian slates that may have been used for the sharpening of bone implements; and pieces of bone, one of which was undoubtedly used to ornament pottery.

A committee has been formed to place a marble bust of Richard Jeffries in Salisbury Cathedral. It is to cost $750, toward which subscriptions are invited.

M. Marey has succeeded in photographing the movements of an animal under water, taking proofs at the rate of fifty in a second, with exposures of from $\frac{1}{1000}$ to $\frac{1}{1000}$ of a second. A set of twelve photographs gives all the phases of the undulations which the medusa impresses upon its umbrella of a locomotor apparatus. Another series exhibits a squid leaping out of the water. A ray has been taken in profile while waving the edges of its flat body; and the curious mode of progression of a comatula has been taken.

A law was announced several years ago by M. V. Neyreneuf relative to the flow of sound through thin cylindrical pipes, which proved identical with the law declared by Poiseuille for the flow of liquids through capilliary tubes. In a later memoir the former author has sought to determine the sounds to be used and the precautions to be taken for giving their flow a well-defined character. He also describes experiments with pipes of varying lengths and diameters, and experiments upon the effect of the kind and substance of the pipe.

Mr. St. George Mivart has been appointed Professor of the Philosophy of Natural History in the University of Louvain, Belgium.

Prof. Marsh gave an account to the British Association of the gigantic *Ceratopsidæ*, or horned dinosaurs, which he had identified in the Laramie beds, near the Rocky Mountains. The Association gave him a vote of thanks for his instructive communication.

Dr. Frithiof Nansen, the Norwegian explorer whose achievement in crossing Greenland from the eastern to the western shore resulted in considerable additions to knowledge, is preparing to start in the spring of 1892 on an expedition the main object of which will be to reach the north pole.

It is shown by Prof. A. Milnes Marshall that there is great variability in nearly allied animals, and even in individuals of the same species. In proof, he refers to the difference between the French edible frog and the British frog, and says that the question as to which of these was the primitive form is a subject for interesting study.

OBITUARY NOTES.

Miss Marianne North, a distinguished English botanist, traveler, and artist, died August 30th. Her career may be said to have begun in 1869, when she started to travel with a view of illustrating the flora of some countries not then perfectly known. She visited on different excursions Teneriffe, Brazil, the West Indies, California, India, Ceylon, Borneo, Java, Japan, Australia, and the Seychelles, and brought back at various times during twelve years collections of drawings in oils and water-colors of the scenery, vegetation, and flora which she had studied in their several habitats. In 1881 she presented a series of 627 pictures to the nation, for which she erected a gallery in Kew Gardens at her own expense.

Thomas Carnelley, Professor of Chemistry in the University of Aberdeen, died August 27th, at the age of thirty-eight years. He was born in Manchester, England; had a brilliant career in Owens College; received the Dalton Chemical scholarship in 1872 for his original investigation of the vanadates of thallium; and gained it for another year, on examination; was private assistant to Prof. Roscoe, and, having studied abroad, became professor in succession at Owens College, the North Staffordshire School of Science, Firth College, Sheffield, University College, Dundee, and the University of Aberdeen. He prosecuted valuable researches in the extension and application of Mendeleef's periodic law; made chemical and bacteriological examinations of the air of dwellings, schools, etc., in Dundee and its district, which aroused interest in ventilation; and besides many contributions to English and foreign chemical journals, published a large book on certain physical constants of chemical compounds.

Signor Orazio Silvestri, a distinguished chemist and vulcanologist, recently died at Catania, Sicily, at the age of fifty-five years. He was an industrious student of the eruptions of Mount Etna, and founded the laboratory on top of the mountain at the height of upward of 13,000 feet.

Prof. Carl Frederik Fearnley, of the University of Christiania, an eminent Norwegian astronomer, died August 23d, in his seventy-third year. He was the author of numerous astronomical and meteorological publications, and had been Professor of Astronomy at the university since 1857.